SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY, 1926.

GENERAL PHYSICS.

908. *Notes on the Perturbation Theory.* **E. Fues.** (Zeits. f. Physik, 35. 3. pp. 224–238, 1925.)—A mathematical paper dealing with the perturbations of a non-degenerate system. Attention is drawn to certain arbitrary elements which are involved in the treatment of Born and Pauli, and Bohlin, and some modifications are made in the form of their results. W. S. S.

909. *Crystal Growth and Solution.* **M. Volmer and G. Adhikari.** (Zeits. f. Physik, 35. 3. pp. 170–176, 1925.)—These experiments are connected with the observations of Volmer and Estermann on the separation of mercury crystals from supersaturated vapour. If a drop of benzophenone on a glass plate be slightly subcooled and then inoculated in the centre, spicules grow rapidly in all directions, at first in the fused mass, then some shoot out beyond its limits and continue to grow. In order to study this phenomenon more closely, the growth of the spicules was recorded microkinematographically. The experiments demonstrate the existence of a stratum of mobile molecules on the surface of crystals and establish the point of departure of a theory of crystal growth elsewhere propounded by M. Volmer (Zeits. phys. Chem. 102. p. 268, 1922.) It follows necessarily that solution and growth of a surface element of the crystal cannot be independent of the nature of the surrounding surface elements. This contradicts the assumption of a speed of growth and solution under certain conditions constant, *i.e.* dependent only on the direction of the surface element. The theory of crystal growth which rests on this hypothesis is thus for small crystals untenable. Seven reproductions of film pictures are given. E. F.

910. *A Contribution to the Knowledge of Ionic Symmetry in the Crystal Lattice.* **W. Ehrenberg.** (Zeits. f. Physik, 35. 8–9. pp. 616–617, 1926.)—In this short note an investigation is described for finding the maximum symmetry of the ions in rock-salt. The lowest crystallographic symmetry of rock-salt permits a difference of optical properties for the directions of the cube edges and surface diagonals, and respecting visible light Lorentz established double refraction from the atomic arrangement [see Abstract 1863 (1922)]. It is now shown that the ionic symmetry is higher than the crystallographic demand. H. H. Ho.

911. *Heat Motion in Solids and Liquids.* **J. Frenkel.** (Zeits. f. Physik, 35. 8–9. pp. 652–669, 1926.)—An analysis of the heat motion of solid crystalline bodies is given on the notion that in the space between the normal lattice points there exist other "irregular" equilibrium positions at which atoms which become "dissociated" from the normal lattice points can vibrate, the dissociated atom passing by successive displacements from one irregular equilibrium point to another, until finally encountering an unoccupied lattice point. Some such mechanism is necessary to explain diffusion in mixed crystals. Probabilities are assigned to the several processes involved, dissociation, displacement, and association, and the variation with temperature of these probabilities is derived. Expressions for the number of atoms dissociated, and for the coefficient of diffusion of these through the crystal, are developed. The electrical conductivity is then evaluated as a function of the temperature. Fluids are regarded as completely dissociated crystals, and similar considerations hold good. By applying Stokes' law to the atoms of the fluid an expression is obtained for the viscosity, and this is fitted on to experimental data for mercury. To confirm the validity of the method, it is applied to find the viscosity of a compressed gas and the result compared with the usual expression given by the kinetic theory. W. S. S.

912. *On the Arrangement of the Micro-Crystals in Rolled Platinum Plate.* **S. Tanaka.** (Kyoto Coll. Sci., Mem. 8. 5. pp. 319–337, Aug., and 9. 3. pp. 197–217, Nov., 1925. In English.)—The arrangement of the micro-crystals in rolled platinum foil was first investigated by means of X-ray photographs. The X-ray patterns obtained are explained as being due to the fact that the greater part of the micro-crystals are arranged with their dodecahedral faces (210) parallel to the surface of rolling, and the normal to a trapezohedral face, which is contained in the dodecahedral face, is parallel to the direction of rolling. Consequently the trigonal axis, which is in the dodecahedral face and perpendicular to the normal to the trapezohedral face, is perpendicular to the direction of rolling. These conclusions appear to be confirmed by reflection of X-rays from the surface of the foil, the foil being bent round a cylindrical wooden rod, spectral lines being produced as in Yoshida's bent mica X-ray spectrometer (*ibid.*, 4. p. 343, 1921). The second paper describes similar experiments on foil rolled in one direction only. The arrangement of the micro-crystals is slightly different, the normal to the trapezohedral face being now inclined to the direction of rolling at about 10° and lying in the plane containing the direction of rolling. J. E.

913. *Continuous Absorption along an Optical Series and Discontinuity-structure at High Frequencies.* **Rita Brunetti.** (Accad. Lincei, Atti, 2. pp. 252–256, Oct., 1925.)—At the border of discontinuity or absorption-bands of the elements in the region of less high frequencies there are two or three minima on a background of diminishing intensity before the progressive increase of intensity which is always found for frequencies higher than that of the band. The breadth of the region within which such a structure appears is of the order of Rydberg's constant. W.

Kossel considers the product $h\nu$, where ν is the frequency of the edge of the band, as measuring the energy necessary to remove an electron, without imparting velocity to it, from an inner orbit to a distance of the order of the atomic radius, and considers the successive minima as corresponding to jumps from an X level to an optical level. This explains the positions of the minima, but leaves uncertain the position of the limit of the series to which the discontinuity of absorption corresponds. The present paper show how certain experimental facts, in the light of Kossel's views, justify a more precise interpretation of the fine structure of absorption bands at high frequencies. This fine structure exists only for discontinuities corresponding to series with few X terms; and it is more developed the higher the ionisation-potential relative to the resonance-potential. A. D.

914. *Effect of the Chemical Bond on the Energy of the Infra-atomic Levels.* **Rita Brunetti.** (Accad. Lincei, Atti, 2. pp. 323–328, Nov., 1925.)—If an element become chemically bonded, the discontinuities of absorption at high frequencies become displaced towards the short wavelengths. From comparison of various Cl, I or S compounds, in which the valencies of these elements are different, it has been thought that valencies have something to do with the phenomenon. Observations on P or K compounds and on the allotropic forms of P and S have directed attention to the structure of the molecule or crystal in which the element takes part. The present paper works out on first principles a theory of the mechanism to which the phenomenon may be due, at least in polar compounds, and takes account of the different functions of the various parts of the fine structure found at the edge of the absorption-discontinuity at high frequencies. This paper is a development of an earlier article (see preceding Abstract). A. D.

915. *Orientation in a Constant Electric or Magnetic Field under Molecular Anisotropy.* **A. Pontremoli.** (Accad. Lincei, Atti, 2. pp. 328–331, Nov., 1925.)—There exists a direction making an angle θ_0 with the constant field such that the number of molecules per unit of volume which have their respective polar axes within an angle θ_0 to $(\theta_0 + \delta\theta_0)$ does not change whether there be an orienting field or not. Then $\cos\theta_0 = \pm\sqrt{1/3}$, independent of the strength of the field and of the greater or smaller dielectric or diamagnetic asymmetry, under all the usual conditions of experiment. A. D.

916. *Field of Force in Atomic Nuclei and Coulomb's Law.* **H. Pettersson.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 9–10. pp. 509–515, 1924.)—The paper discusses the law of force in the region of the nucleus of the atom with regard to the work of Rutherford, Chadwick, Bieler and the author relating to this question. A. B. W.

917. *Forces between Atoms and Ions.* **J. E. Lennard-Jones** (formerly **J. E. Jones**). (Roy. Soc., Proc. 109. pp. 584–597, Dec. 1, 1925.)—The scope of the work previously published [Abstract 452 (1926)] is extended to include krypton-like and xenon-like ions, this being done by deducing the fields of krypton and xenon from crystal observations alone. From the interatomic distance and compressibility of rubidium bromide crystals, together with the refractivities of Br^-, Kr and Rb^+, the force-field of krypton is calculated. The force-field of xenon is calculated in a similar manner from the constants of cæsium iodide, the fields of the associated ions being derived from those of krypton and xenon. The methods previously described are then applied to deduce the fields between any two of a series of neon-like, argon-like, krypton-like and xenon-like ions. Applications of the results obtained are made to evaluate the interatomic distances of the crystals of thirty-two substances, including sixteen alkali haloids. For the latter, the calculated values are found to lie, with one exception, within 1 or 2 % of the observed distances. Calculations are made also of the compressibilities and crystal energies of these crystals, and yield results in satisfactory agreement with the observed values. T. H. P.

918. *Influence of "Inner Development" on Ionic Radii.* **M. v. Stackelberg.** (Zeits. phys. Chem. 118. pp. 342–346, Dec. 30, 1925.) —X-ray analyses of rare earth oxides by V. M. Goldschmidt have shown that in passing from *La* to *Lu* there occurs a progressive decrease in the radius of the ion. This is termed the Lanthanum contraction, and is related to inner development in the N and O electron levels. The author anticipates similar contractions at the other places in the periodic table where inner development takes place, and on this assumption gives an explanation of the form of the observed variation in ionic radius in passing down a vertical column of the periodic table. W. S. S.

919. *Distribution of Electrons among Inner Quantum Levels.* **D. M. Bose.** (Zeits. f. Physik, 35. 3. pp. 213–218, 1925.)—According to Stoner's theory of atomic structure the atoms of Sc (21) to Cu (29) are characterised by the formation of two new sub-groups of electrons in the inner 3-quantum levels, M_{32} and M_{33}. By plotting the Bohr magneton number against the number of electrons in the ion, it is shown that the elements Sc (21) to Fe (26) correspond to the development of the M_{33} sub-group, and Co (27), Ni (28) and Cu (29) to the M_{32} sub-group. Using Hund's scheme for the electron distribution among the levels M_{33}, M_{32}, and N_{11}, and making certain assumptions, the author calculates the Bohr magneton numbers for the atoms and ions of these elements. These show general agreement with the experimental values of Gerlach and others. The numbers of spectroscopic magnetons are also calculated and compared with experimental values. W. S. S.

920. *Evolution.* **O. Lodge.** (Nature, 116. pp. 939–942, Dec. 26, 1925. Huxley lecture delivered at Charing Cross Hospital, Dec., 1925.) —This is an interesting popular discussion of the thesis that there is no essential opposition between creation and evolution. One is the method of the other. An account of the process of cosmic evolution, as far as modern science is able to formulate it, is based upon the work of Eddington and Jeans, and is briefly referred to in this report. The question was then raised as to whether a linear process of evolution—a procedure in time with a beginning and an end—was likely to be the last word, or whether there was any way of overcoming the dissipation of energy and prospective stagnation. G. W. de T.

921. *Critical Remarks on a Repetition of the Michelson Experiment on Mt. Wilson.* **H. Thirring.** (Zeits. f. Physik, 35. 10. pp. 723–731, 1926.)—The results of D. C. Miller [Abstract 2438 (1925)] from the repetition on Mt. Wilson of the Michelson experiment are not in accord with the Stokes-Planck theory of the ether drift, since, according to this theory, the gradient of the relative velocity of earth and ether cannot be so great as to attain the value found by Wilson (9 km./sec.) at the height of Mt. Wilson. The observable ether drift must during any day be constant in amount and direction. From this the theoretical interference shift should be calculable as a function of the azimuth of the interferometer for different hour-angles and different inclinations of the ether drift with respect to the earth's axis. A comparison of the observations of Miller shows that one must assume an error of observation of the magnitude of the total effect measured in order to fit the curve of observations to the calculated one. It follows upon this that the effects observed cannot be real, having nothing to do with the earth's motion, but must be related to some unexplained disturbance. J. E.

922. *A Supposed Relativity Method of Determining the Size of a Gravitating Particle.* **H. T. H. Piaggio** and **J. Critchlow.** (Phil. Mag. 1. pp. 67–71, Jan., 1926.)—A singularity in Schwarzschild's solution of Einstein's equations of the gravitational field of a particle, which has been widely interpreted as indicating a definite size for a gravitating particle, is shown to be merely a mathematical property of a transformation of coordinates without any physical significance.

J. S. G. T.

923. *Field of a Thick Spherical Shell on Einstein's Theory of Relativity.* **J. T. Combridge.** (Phil. Mag. 1. pp. 276–279, Jan., 1926.)—An expression involving two mixed tensors is derived for the line-element in the field of a heterogeneous gravitating shell such that the layers of equal density are concentric spheres. In a concentric cavity within such a shell space-time is Euclidean. The constant of integration in the usual solution for the field of the sun is identified with the inertial mass of the sun. "Potentials" over any spherical surface having the origin as centre and lying in the material are those due to matter within the spherical surface, matter outside this surface contributing nothing to the field. J. S. G. T.

924. *The Relativistic Two-body Problem.* **T. Takeuchi.** (Phys. Math. Soc. Japan, Proc. 8. p. 2, Jan., 1926.)—The expression obtained when the isotropic form of the line-element is transformed from a system S′ to another S, relatively to which S′ is in uniform motion, is shown to correspond with that obtained by the method of retarded potentials. [See Abstract 274 (1925).] J. S. G. T.

925. *Electrodynamic Effects of the Earth's Motion at Great Heights.* **R. Tomaschek.** (Ann. d. Physik, 78. 8. pp. 743–756, Jan., 1926.)—If the ether partakes of the translational motion of the earth at the earth's surface and at great distances is stationary relative to the fixed stars, it is possible that the transition may be detected by suitable experiments at the earth's highest points. In the experiments described a stationary condenser is charged, and arrangements are made to detect the magnetic field and the torque which are expected to be set up if the condenser is moving with respect to the surrounding ether. Observations were made at Heidelberg, Königstuhl and Jungfraujoch corresponding to heights of 120, 570 and 3457 metres respectively. The accuracy of the magnetic experiments was such that a velocity, ether to earth, of 20 metres per sec. could be detected. In the torque experiments a velocity of 3 km./sec. was necessary to give a perceptible deflection. No indication of the expected effect was observed at any of the stations in either experiment. The author concludes that, at the heights worked at, the conditions were scarcely different from those at the earth's surface, and hence a negative result in the Michelson-Morley experiment would be expected. This, however, is not in agreement with the work of D. C. Miller, who obtained a positive result in the Michelson-Morley experiment at a height of 1734 metres corresponding to a relative velocity of about 30 % of the earth's orbital velocity. W. S. S.

926. *Gravitation referred to a Flat Space-Time.* **T. Takeuchi.** (Phys. Math. Soc. Japan, Proc. 8. pp. 3–4, Jan., 1926.)

927. *Gravitational Motions in one Dimension.* **T. Levi-Civita.** (Accad. Lincei, Atti, 2. pp. 365–371, Nov. 15, 1925.)—Considering an unlimited medium (*e.g.* cosmic dust) subject solely to the mutual attraction of its material particles, and on the particular hypothesis that at a given moment the density μ is a function only of the coordinate x, the Newtonian attraction a, at that moment exerted by the system on the unit of mass at a point x, y, z, will also be a function of x solely. In that case, provided the velocity v be, at the same moment, directed along Ox and be also a function of x only, it is clear that the motion of the system will start and continue parallel to the axis of x, all the points whose coordinate is x behaving alike. The transverse coordinates y, z may thus be neglected, and it is only necessary to consider the rectilinear motion of the particles along a line taken as the axis Ox. The paper is entirely mathematical. E. F.

928. *Theory of Gravitation.* **W. Laschkarew.** (Zeits. f. Physik, 35. 6. pp. 473–476, 1926.)—The equations of Einstein's general theory of relativity are deduced by combining the results of the special theory with results based upon the hypothesis of the existence of an accelerated ether. J. S. G. T.

929. *A Note on K. Schaposchnikow's Paper, "Newtonian Mechanics and Light Quanta."* **V. S. Vrkljan.** (Zeits. f. Physik, 35. 7. pp. 495–498, 1926.)—The problem of light quanta and the circular polarisation of light has been investigated by Schaposchnikow [see Abstract 776 (1925)], and the work is extended by the present author to elliptic oscillations of light. Both authors assumed the light quantum to be a straight cylinder, of circular and elliptical cross-section respectively. It is now shown that this assumption is a special arbitrary one, and unnecessary, since the rotational impulse $h/2\pi$ can be derived without any special assumption as to the form of the light quantum on the basis of the hypothesis that the inner oscillation energy $h\nu/2$ is added to the light quantum, and that the distribution of mass $h\nu/c^2$ is axially symmetrical. H. H. Ho.

METEOROLOGY AND GEO-PHYSICS.

930. *The Heated Hair Hygrometer as a Means of Measuring the Water Content of Clouds and Fog.* **F. Albrecht.** (Meteorolog. Zeits. 42. pp. 468–477, Dec., 1925.)—Few direct measurements having hitherto been made on the water contents of clouds, in spite of its importance, the author devised a method for its measurement. The principle employed was to determine the water condensed on a bundle of hair when the air containing the cloud was drawn over the hair of a hair hygrometer. It was shown that the cloud density and the increase of the relative humidity found by the hygrometer were usually dependent on one another. To obtain the measurements in cases of saturated air it was necessary to heat the hair, a platinum wire surrounding it for this purpose and being heated electrically. The relative humidity can then be determined in the cloud-free air from the moisture content, the wind velocity and the rate of supply of heat. The theoretical and experimental bases of the method are investigated, the practical measurements having been made in the summer of 1924 on the Sonnblick with an apparatus whose constants were fixed by tests in a wind channel under varied conditions. Tests in fog were also made in Potsdam in the autumn of the same year. Curves illustrate a typical case on the Sonnblick when cumulus clouds passed over intermittently. R. S. R.

931. *Graphical Methods for the Determination of Adiabatic Changes of State for Damp Air.* **J. E. Fjeldstad.** (Geofysiske Publ. 3. 13. [25 pp.], 1925.)—The series of tables and graphs employed by Hertz and by Neuhof to connect pressure and temperature has been extended by the author to cover the range 1100 mb. to 200 mb. and 40° C. to − 60° C. Commencing with the equations holding for dry air and water vapour, expressions are obtained which cover the range through the stages of dry air, unsaturated vapour, rain, hail and snow. In the snow stage the author differs from Hertz and Neuhof by assuming that the latent heat of sublimation of ice is approximately constant and equal to 677 calories, an assumption which involves a variation of the latent heat of fusion of ice with temperature. An adiabatic height formula is developed and calculations continued through the range for unsaturated vapour, rain, hail and snow. Many examples are given of the use of the tables to obtain changes of temperature, pressure or water content under varied conditions, and a comparison is made of results obtained by using the author's equations and those of Hertz and Neuhof. R. S. R.

932. *Commission for the Exploration of the Upper Air. Report of the Meeting in London, April* 16–22, 1925. (Meteorology Office, Air Ministry, M.O. 281. [79 pp.], 1925.)

933. *The Variations of Ozone in the Upper Atmosphere.* **H. Buisson and C. Jausseran.** (Comptes Rendus, 182. pp. 232–234, Jan. 18, 1926.)—Daily observations of variations of ozone in the very pure atmosphere at Digne, 600 m. above M.S.L., were taken from July to September, 1925. The apparatus used was similar to that described in Abstract 76 (1922). The mean amount of ozone, expressed as the thickness of pure ozone at atmospheric pressure, was found to be 3 mm., a figure which is in close agreement with the results obtained from other localities in 1920. The variations noted amounted to about 15 % of the mean value, but no correlation could be found between the thickness of ozone and local meteorological conditions. A. W. L.

934. *Absorption of Height Radiation in Water.* **L. Myssowsky and L. Tuwim.** (Zeits. f. Physik, 35. 4. pp. 299–303, 1925.)—Reference is made to results obtained by Hess and Kolhörster in the free air, and under water and ice on the absorption of penetrating radiation [Abstracts 259 (1914) and 2963 (1924)]. In the present tests measurements were made at various depths up to 19 m. in Lake Onega, N. Russia, over three days in July, 1925. A number of readings had to be discarded on account of unfavourable weather, but from the values obtained under quiet conditions a simple exponential curve was constructed after deduction of a constant quantity. The absorption coefficient obtained for water was $(3\cdot6 \pm 0\cdot2) \cdot 10^{-3}$ cm.$^{-1}$, which is ten to eleven times smaller than that for the γ radiation of RaC. R. S. R.

935. *High-frequency Rays of Cosmic Origin.* **R. A. Millikan.** (Nat. Acad. Sci., Proc. 12. pp. 48–55, Jan., 1926. Ann. d. Physik, 79. 6. pp. 572–582, April 6, 1926. Nature, 116. pp. 823–825, Dec. 5, 1925.)—Experiments carried out by the author, in which recording electroscopes were immersed to different depths in snow-fed lakes (free from radio-active contamination), indicate an extremely penetrating radiation of cosmic origin. The ionisation indicated by the electroscope decreased steadily with depth, down to 45 ft. below the surface, equivalent to 45 + 23 ft. of water (the atmosphere above the lake being equivalent to 23 ft. of water), or the equivalent of 6 ft. of lead. The most penetrating X-rays produced in hospitals cannot penetrate half an inch of lead. These experiments were checked by another set of observations in another snow-fed lake 300 miles away and 7000 ft. lower. The wave-length of the shortest waves observed is 0·0004 Å.U., or only 1/50th of that of the hardest gamma-rays previously known. The longest wave-length found is 0·00067 Å.U. It is suggested that these extremely hard rays stimulate, on striking matter, softer rays of about the frequency predicted by the theory of the Compton-effect. The penetrating rays come to the earth with equal intensity day and night at all hours of the day or night, and with practically the same intensity in all directions. A. B. W.

936. *Cosmic Rays.* **C. S. Wright.** (Nature, 117. pp. 54–56, Jan. 9, 1926.)—The note deals with the history of investigations on rays of cosmic origin. Reference is specially made to the recent observations of Millikan [see preceding Abstract], and it is pointed out that these observations are in one important particular in disagreement with Kohlhörster's results [see Abstract 1098 (1924)]. Kohlhörster discussed the source of the cosmic rays, and tentatively ascribed the observed effects to sources in the neighbourhood of the Milky Way. Millikan, however, states that the radiation is constant at all times day or night.

The paper concludes with general considerations relative to the measurement of such penetrating cosmic rays at lower altitudes, where the difficulties of observation are greatly complicated by other sources of disturbance (*e.g.* radio-activity of the earth). A. B. W.

937. *Origin of Terrestial Helium and its Association with other Gases.* **S. C. Lind.** (Nat. Acad. Sci., J. 11. pp. 772–779, Dec., 1925.)—A survey is made of the discovery and properties of helium and of theories advanced to explain its origin in the earth's crust. The local accumulation of He in the earth as caused by the local concentration of parent radio-active substances is considered, and also the conditions favourable for this accumulation. It is shown that the capping of shale with clay will form a gas seal and prevent escape of the gas. Lastly, the association with N_2, H_2, and O_2 and the possible action of α-rays in producing decomposition of substances containing these elements is examined. R. S. R.

938. *Thermic Heterogeneities in Fulminating Material.* **E. Mathias.** (Comptes Rendus, 181. pp. 1038–1040, Dec. 21, 1925.)—The nature of ball lightning is discussed in relation to the temperature of the fulminating material; the distribution of temperature is highly heterogeneous, owing to the mixing of hot particles from the interior of the mass with colder particles from the surface layers. A. W. L.

939. *The Colour and Chemical Heterogeneities of Fulminating Material.* **E. Mathias.** (Comptes Rendus, 181. pp. 1111–1114, Dec. 28, 1925.)—The author discusses eighty-one examples of ball lightning, in spherical or other well-defined forms; the colours observed on forty-seven occasions are those obtained from the cooling of a black body, and twenty cases show a bluish colour, either alone or superimposed upon the black-body colouring. The black-body radiation is emitted from the pure fulminating material, and the additional blue is attributed to the burning of sulphur absorbed from the atmosphere. A. W. L.

940. *Contribution to the Study of Fulminating Material. The Black and White Globes without Light of their Own.* **E. Mathias.** (Comptes Rendus, 182. pp. 32–34 Jan. 4, 1926.)—The globes, assumed to be masses of fulminating material surrounded by a shell of vapour, are classified according to whether they present a solid or diffuse appearance. The colour of globes appearing as cloudlets depends upon the relative amounts of black smoke and water-vapour emitted during carbonisation of impurities picked up from the atmosphere. In order to explain the solid appearance of certain globes, a high electrostatic potential is assumed for the core; organic atmospheric impurity is thus attracted and carbonised, and gives rise to a conducting cloud which is prevented from dispersing by the electrostatic pressure. A. W. L.

941. *The Energy of Fulminating Material at the Moment of Explosion.* **E. Mathias.** (Comptes Rendus, 182. pp. 194–197, Jan. 18, 1926.)—The values deduced for the energy of pure fulminating material, at the moment of explosion, are in the neighbourhood of 2860 kilogramme-metres per cubic centimetre and 5145 calories per gramme. A. W. L.

ASTRO-PHYSICS.

942. *Cause of Anomalous Determination of Time.* **M. R. Madwar.** (Roy. Astron. Soc., M.N. 86. pp. 137–143, Jan., 1926.)—Sampson has shown [see Abstract 1256 (1922)] that the erratics in clock correction are mostly due to the adopted instrumental constants; the elimination of the level error and the introduction of a quantity A in the time reduction caused a disappearance in the erratics of the clock, Shortt No. 4. The present paper gives similar results for the running of Riefler No. 258 for the years 1915 January–1923 December, together with charts of the observed and adopted clock errors on a time basis. The mean erratic is reduced from ± 0·03 sec. to ± 0·02 sec., and certain large erratics are wiped out when the reduction is carried out with n (of Mayer's formula) and A. The author also investigates the horizontal and vertical components of the tide-generating forces of moon and sun, and the effect of the rising tide on a plumb-line near the coast; he finds the combined result to be a small and almost negligible quantity. A. S. D. M.

943. *Meridian Circle Observations made at the Lick Observatory, University of California,* 1902–1924. **R. H. Tucker.** (Lick Observat. Publ. 15. [261 pp.], 1925.)

944. *N.G.C. 6822, a Remote Stellar System.* **E. Hubble.** (Mt. Wilson Observat. Contrib. No. 304. Astrophys. J. 62. pp. 409–433, Dec., 1925.)—This object is a very faint cluster of stars and nebulæ resembling the Magellanic Clouds. Detailed investigations show that if a distance of 214,000 parsecs is assumed on the basis of the period-luminosity relation of 11 Cepheids contained in it, the dimensions, luminosities, and densities, both of the system as a whole and of its separate members, are of orders of magnitude familiar in our own galactic system. The important conclusion may therefore be drawn that the Cepheid criterion of distance offers a trustworthy means of exploring even extra-galactic space. M. A. E.

945. *Mean Distribution of Stars according to Apparent Magnitude and Galactic Latitude.* **F. H. Seares, P. J. van Rhijn, Mary C. Joyner** and **Myrtle L. Richmond.** (Mt. Wilson Observat. Contrib. No. 301. Astrophys. J. 62. pp. 320–374, Dec., 1925.)—70,000 stars from the Mt. Wilson Catalogue of selected areas ($m = 13\cdot5$ to $18\cdot5$) and from Tables II and IV, Groningen Publication No. 27 ($m = 4\cdot0$ to $9\cdot0$), and 1,400,000 stars from the astrographic zones ($m = 9\cdot0$ to $13\cdot5$) are distributed according to $\log N_m$ (N_m = number of stars per square degree brighter than magnitude m). A table is given of the mean values of $\log N_m$ extrapolated to photographic magnitude 21·0, with groupings for each half-magnitudes from 4·0 to 21·0 for galactic latitudes 0°–20°, 20°–40°, 40°–90° and 0°–90°, and also for visual magnitudes 0°–90°. From these it is deduced that there are for the whole sky 890,000,000 stars to the 21st photographic magnitude, and 1,000,000,000 to the 20th visual. A table of the values of $\log (dN_m/dm)$ is given for $m = 4\cdot0$ to $21\cdot0$ (photographic) and galactic latitudes 0°, 30°, 60°, 90°, 0°–20°, 20°–40°, 40°–90°, 0°–90°, and for $m = 4\cdot0$ to $20\cdot0$ (visual) and galactic latitude 0°–90°, and for a, b, c and m_0 ($\log dN_m/dm = a + bm + cm^2$); the run in the differences show that the total number of stars in the system is finite. Assuming

$$N = 41{,}253 \times \int_{-\infty}^{+\infty} e^{\frac{1}{M_0 d}(a+bm+cm^2)}\,dm$$

and integrating to $m = +\infty$, we get for the three zones, 0°–20°, 20°–40°, 40°–90°, the values $N_1 = 2\cdot84 \times 10^{10}$, $N_2 = 0\cdot12 \times 10^{10}$, $N_3 = 0\cdot02 \times 10^{10}$, and the sum $N = 2\cdot98 \times 10^{10}$, as the total number of our system's stars. The numbers for the three zones show that 95 % of all the stars lie within 20° of the galactic plane, and less than 1 % in the third of the sky between 40° and 90° of galactic latitude. The same table also gives the total amount of starlight in terms of a 1·0 magnitude star as 1092 (visual on Int. scale) and 577 (photographic on Int. scale) as compared with van Rhijn's 1440 or Yntema's 1350 (both visual on Harvard scale). The maximum amount of light is contributed by 11th and 12th magnitude stars. [See Abstract 2051 (1925)]. A. S. D. M.

946. *Electrostatic Deviation from the Perfect Gas Law in a Star.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 86. pp. 2–8, Nov., 1925.)—Recently Fowler and Guggenheim [Abstract 493 (1926)] have published figures for the correction required for the deviation from perfect gas behaviour of ionised stellar material due to electrostatic forces. The theory due to Rosseland appears to be unsound in the matter of the approximations made. It is shown that one term allows a negative density of ions at certain positions, and a method of removing the obvious anomaly is suggested. The electrostatic terms of Fowler and Guggenheim are then reduced to about one-third of their previous value. The theory is still not perfect. A. Wh.

947. *Absorption Lines in Stellar Spectra.* **R. H. Fowler.** (Roy. Astron. Soc., M.N. 85. pp. 970–977, Oct., 1925.)—Consists of addenda and corrigenda to the theory of absorption lines as presented by Fowler and Milne [see Abstracts 2459 and 2575 (1925)]. In particular the formulæ given previously for maxima of stellar absorption lines are made more accurate. The theoretical positions of the maxima of the principal lines of Ca^+, Sr^+, Ba^+ are recalculated on Miss Payne's data, and are shown to be at lower temperatures than the observations indicate. A reason is given for this.

The rate of decay of lines on the high-temperature side of their maxima is re-investigated theoretically; the striking difference between the Balmer lines and the lines of the Fe group is in full agreement with the theory. A. C. M.

948. *Rosseland's Integral for Stellar Absorption Coefficients.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 85. pp. 979–984, Oct., 1925.)—A consideration of the accuracy obtainable in the calculation of k (the mean absorption coefficient) when Rosseland's integral [see Abstract 2462 (1924)] is used, and when alternatively an "arithmetic" mean is used, particularly with regard to mixtures. The latter procedure gives more accurate determination for mixtures; when there is approximately "grey" absorption the arithmetic means of the constituents can be directly combined, and the result is independent of the weighting factor used in the process.

The importance of this is in its application to the photospheric layers of all stars showing an approximately black-body continuous spectrum, *e.g.* the sun. Other differences of the same character are considered. A. C. M.

949. *The Balmer Absorption Series in Stars of Class A.* **Cecilia H. Payne and Mary Howe.** (Harvard Coll. Obs., Circ. No. 287. [6 pp.], 1925.)

950. *Ionisation in Stellar Atmospheres and Steric Factor.* **M. N. Saha.** (Roy. Astron. Soc., M.N. 85. pp. 977–979, Oct., 1925.)—A reply to M. C. Johnson [Abstract 2463 (1924)] with regard to his objections to Saha's views on the "steric factor." A. C. M.

951. *Theory of Pulsating Stars.* **G. Lemaître.** (Harvard Coll. Obs. Circ., No. 282. [6 pp.], 1925.)—Eddington has applied the hypothesis of pulsating stars to the Cepheid variables as a supplementary test of the relation between mass and absolute luminosity which he deduced from his theory of the radiative equilibrium of a star [Abstract 1730 (1924)]. Here, by converse procedure, his theory is applied to other stars of known absolute magnitude, in order to see if their variation can also be accounted for by pulsation. It appears to be possible to account thus for the numerical value of the period of short-period variables, long-period variables, and even a peculiar star of O-type; and the result suggests that a complete theory of the complex phenomena occurring in the intermediate zone between the atmosphere and the inside of a pulsating star might lead to widely different features of the light-curve and the velocity-curve, the particular behaviour of the typical Cepheids being but a particular case.

M. A. E.

952. *Stellar Globular Clusters and their Relations in Space.* **C. Parvulesco.** (Bull. Astronomique, 5. 1. pp. 5–146, 1925.)—The author concludes that globular clusters are extra-galactic and strangers to our system. He finds that the inclinations of their major axes, where measurable, bear no relation to the Milky Way, indicating that they are independent of it. By studying the distribution of stars in Messier 9, 10 and 12 [see Abstract 246 (1926)], and of a theoretical globe of gas in adiabatic equilibrium, he has found a family in integral curves of the differential equation which such a density satisfies, constituting a base for the analytical study of the dynamical conditions. The accumulation of Cepheid variables and giant stars in these dense regions of the universe suggests a correlation between them and the degree of concentration, which must therefore play an important part in the transformation of single stars into giants of small density or pulsating variables. He describes the characteristics of globulars and their positions in space, comparing these with spirals and planetaries. He finds the laws of their luminosity and density; the principle of their equipartition of energy; the frequency of impacts in them; the equilibrium conditions of an isolated and non-rotating cluster (M 9 is the most concentrated of the three, and M 10 the least stable); their dynamics; their parallax; and the evolution of isolated stellar clusters. He gives a list of 91 globulars, with their N.G.C. and Messier numbers; galactic position; mean diameter; number of included stars; magnitude of their most luminous stars; parallaxes by Shapley and Charlier; integral magnitude, absolute and by Holetschek, Parvulesco; direction and inclination of major axis; and line of sight motion. He attributes their avoidance of the Milky Way to a belt of obscure matter surrounding this, which therefore blots out objects beyond it, but allows us to see nearer objects; such obscure matter ought also to be present in globulars, and should tend in time to make them concentrated, thus giving birth to a spiral.

A. S. D. M.

953. *Extension of the Henry Draper Catalogue of Stars.* **H. Shapley.** (Harvard Coll. Obs., Circ. 278. [8 pp.], 1925.)—An examination of this Catalogue revealed inequalities of survey in different parts of the sky, owing principally to better observing conditions at Arequipa than at Harvard. Two years ago it was planned to balance the survey for faint stars, and to explore certain Milky Way fields which are of special importance in current studies of stellar distribution. The results are being published, including spectra, photographic magnitudes, and positions, in instalments of a few thousand stars. The material first completed covers an area in the Cygnus star cloud of about 80 square degrees; and it is found that the extension here includes stars about two magnitudes fainter than the Catalogue. A diagram showing the distribution in spectral classes makes apparent a predominance of A stars and a notable paucity of K, compared with 8th-magnitude stars elsewhere in the Galaxy.

M. A. E.

954. *The Magellanic Clouds; Spectral Composition of the Foreground.* **H. Shapley** and **Margaret L. Walton.** (Harvard Coll. Obs., Circ. 288. [5 pp.], 1925.)—It is desirable to know the maximum absolute brightness of stars in the Magellanic Clouds, distinguishing them from stars of the foreground. An investigation has therefore been made of all stars brighter than 10th apparent magnitude in the area of each Cloud, and the number and distribution in spectral class of these has been compared with what is found in other regions of the same galactic latitudes. It is concluded that there is no definite evidence of stars belonging to the small Cloud brighter than 10th magnitude, which corresponds with absolute magnitude − 7·5; but that in the Large Cloud there are probably some twenty or thirty stars brighter than this, equalling − 8·5 absolute magnitude. Any one of these may be a compact group, unresolvable into individual stars at the distance of the Cloud, but even if so the individuals must be as bright as the brightest stars known in the Galaxy. M. A. E.

955. *The Nature of Spectroscopic Binaries.* **O. Struve.** (Roy. Astron. Soc., M.N. 86. pp. 63–76, Dec., 1925.)—In a previous paper [Abstract 501 (1925)] it was shown that stars with variable radial velocity fall into two groups: the first contains those that obey Kepler's third law, and are without doubt actual binaries; the second contains those not obeying that law, and their periods are all less than 2·4 days, the number increasing with decreasing period. The latter appear to be related to the Cepheid variables. The relationship between period and velocity variation has now been further investigated, the stars being classed according to spectral type. The values of the shortest possible periods at which double stars can exist have been computed, these values corresponding to actual contact of the components; and the frequency curve of spectroscopic binaries of different period has been determined. The striking resemblance of this curve to that of the variable stars indicates that there exists some relation between them. Jeans has suggested that Cepheids and long-period variables are binaries in process of fission, the period of oscillation or pulsation, which finally leads to fission, not coinciding with that of rotation. The author considers that stars of the β Canis majoris type may represent this stage, and that the true Cepheids have reached a further stage, where a definite period has become prevalent, though separation is not yet complete. After fission has occurred, the components obey Kepler's third law. Except for the difficulty that this scheme provides no place for wide doubles with periods of hundreds or thousands of years, which may possibly have a different origin, Jeans' theory seems to fit the various observed characteristics of spectroscopic binaries remarkably well. M. A. E.

956. *Preliminary Orbit of the Long-period Spectroscopic Binary 37 φ Orionis.* **O. Struve.** (Astrophys. J. 63. pp. 60–66, Jan., 1926.)—The orbital elements of the spectroscopic binary 37 φ Orionis were derived from fifty-six spectrograms, covering an interval of twenty-two years. The period is 8·4 years; $\gamma = + 33 \cdot 2$ km./sec.; K = 13·3 km./sec.; $e = 0 \cdot 22$; $\omega = 105^\circ$; $a \sin i = 54$ million km. The calcium lines H and K show oscillations with the same period, but $\gamma = + 16 \cdot 2$ km./sec. and K = 7·5 km./sec. It was shown that these oscillations cannot be due to blending of a truly "stationary" line and a stellar line. The suggestion is made that it might be due to some sort of whirls in a calcium cloud, caused by the rapid motion of the components of a spectroscopic binary. [See also Abstract 2016 (1909).] AUTHOR.

957. *Winged Lines in the Solar Spectrum.* **Charlotte E. Moore and H. N. Russell.** (Astrophys. J. 63. pp. 1–12, Jan., 1926.)—The most conspicuously winged lines in the solar spectrum were selected by an independent examination of the Mt. Wilson and Rowland photographs, and classified according to the degree of widening. The 138 widened lines are due to eleven elements, Fe, Mg, Ca, Ni, H, Ti, Na, Al, Si, Cr and Sr. Iron gives most of the lines (89); Ca^+ the strongest (H and K). Energy-level of origin.—The widened lines all originate in low energy-levels, those arising from the lowest levels being the most widened. Strong components of multiplets are more widened than weak. Relative abundance of elements.—Using a rough criterion for the "total widening" of the lines, the order of the elements is as given above. This is closely parallel to that of the relative abundance in the composition of the earth, the principal exceptions being explainable. The main cause of widening is shown by this evidence to be almost entirely the abundance in the solar atmosphere of atoms which are in a condition to absorb the line in question. Widening in the laboratory shows little correlation with widening in the sun, and is probably due to quite different causes. Tables of the widened lines and their spectroscopic relations are given. AUTHORS.

958. *Lines in the Spectra of Red Stars.* **P. W. Merrill.** (Mt. Wilson Observat. Contrib. No. 306. Astrophys. J. 63. pp. 13–19, Jan., 1926.) —Lines of various elements in stellar spectra of classes M, N and S.—The behaviour of lines of H, He, Li, Na, K, Mg, Ca, Sr, Ba, Al, Ti, Zr, V, Cr, Mn and Fe is described, especial attention being paid to the series classification of the lines and their relative intensities in the various spectral types. AUTHOR.

959. *Internal Motions of Messier 33.* **K. Lundmark.** (Mt. Wilson Observat. Contrib. No. 308. Astrophys. J. 63. pp. 67–71, Jan., 1926.) —The photographs measured and discussed by van Maanen (Mt. Wilson Contr. No. 260) were remeasured with the same measuring instrument and discussed by the same method. The same comparison stars and nebular points were selected for measurement. Any systematic difference in results is therefore of personal origin. The values found for the proper motion are $\mu_\alpha = - 0'' \cdot 0015$, $\mu_\delta = - 0'' \cdot 0050$; van Maanen's results are $+ 0'' \cdot 0034$ and $- 0'' \cdot 0044$ respectively. The annual rotational components can be represented by $- 0'' \cdot 00084 + 0'' \cdot 00032 \rho$, and $+ 0'' \cdot 01063 + 0'' \cdot 00119 \rho$ (van Maanen), ρ being the radial distance in minutes of arc. For the mean distance of the 399 nebular points, $\rho = 7' \cdot 6$, these expressions for the rotational component become $+ 0'' \cdot 00160$ (Lundmark) and $+ 0'' \cdot 01969$ (van Maanen). The correlation coefficients between the rotational and radial components found by the two measures are $r_{\text{rot.}} = 0\cdot282 \pm 0\cdot046$ (m.e.), $r_{\text{rad.}} = 0\cdot453 \pm 0\cdot040$ (m.e.). AUTHOR.

960. *Stellar Temperatures.* **J. Hopmann.** (Zeits. techn. Physik, 7. 1. pp. 12–18, 1926.)—A review of the methods which have been used to determine surface temperatures of the stars, with a critical summary of the results so far obtained and a comparison with related work on stellar diameters and variable stars. M. A. E.

961. *The Evolution of the Stars.* **J. H. Jeans.** (Nature, 117. pp. 18–21, Jan. 2, 1926.)—If the hypothesis of annihilation of stellar matter is accepted as explaining the source of stellar radiation [Abstract 496 (1925)], the same hypothesis can explain the evolution and spectral changes of a star; but to account for the great differences in radiation per unit mass among stars we must suppose that they consist of a mixture of different kinds of matter which radiate at different rates. A mathematical study of the conditions of stellar equilibrium (Roy. Astron. Soc., M.N., Jan., Mar. and June, 1925) shows that the mass, rate of emission and surface-temperature of a spherical star in equilibrium are connected approximately by an equation which, if exact, would enable us to solve very simply the problem of its evolution. There are, however, complications which modify the main solution, but in such a way as to support it; and five of these are dealt with here. It is shown that each of these modifications provides an explanation of an observed fact, *viz.* the division into giants and dwarfs, the occurrence of white dwarfs, the concentration of stars which follow the "main sequence" of Hertzsprung and Eddington, the early spectral types of newly-formed binaries, and possibly the phenomena of long-period and short-period variable stars. It appears probable that our terrestrial elements are merely a residue of practically non-transformable material; hence, although we can watch matter being transformed into energy in the stars, we shall never be able to imitate the process on earth. M. A. E.

962. *Observations of (Ch. 1375) X Persei in 1907–25.* **A. N. Brown.** (Roy. Astron. Soc., M.N. 86. pp. 101–108, Jan., 1926.)

963. *Planetary Temperatures.* **E. Schoenberg.** (Phys. Zeits. 26. pp. 870–898, Dec. 23, 1925.)—This is a summary of the attempts which have been made to estimate the surface temperatures of the planets. The difficulties of the problem are greatest with youthful planets, such as Jupiter and Saturn, which are still gaseous and radiating heat from their centres, as well as receiving it from the sun; they are less in the case of planets with a solid surface and an atmosphere, such as Mars and Venus; least with those which have no appreciable atmosphere, such as the minor planets and the moon. A review is given of the early work of Christiansen, Lowell, Poynting, Arrhenius, Very, etc., and of the comprehensive mathematical treatment of the problem by Milankowitsch. With the recent bolometrical observations in America the problem has entered a new stage, which is full of promise, although not all the results have yet been published. The methods are described and the results discussed. Those for Venus are doubtful, but the high temperatures deduced for Jupiter and Saturn are reliable and of great interest, and a more detailed study may throw much light on the constitution of the giant planets. It is now possible to estimate separately the temperatures of different portions of a planetary disc; and the results of Coblentz show that the dark regions on Mars are quite warm enough to be covered with vegetation during the Martian summer, even if it is only of a Polar type like that of our Siberian tundras. Finally, a new method has been suggested by the Russian astronomer Fessenkow of determining the temperature and the depth of atmosphere (if any) on the moon by measuring the brightness of her twilight zone, and this might perhaps be applied to Venus and Mars. M. A. E.

964. *Movement of the Perihelion of Mercury.* **J. Chazy.** (Comptes Rendus, 181. pp. 1053–1055, Dec. 21, 1925.)—Grossmann has shown that the values of this constant as determined by le Verrier and by Newcomb, which agree so well with the theory of relativity, are subject to considerable uncertainty. In view of the extreme importance of the question it appears very desirable that a new study should be made of the divergence between Newtonian theory and observation, based on the more accurate data which are now available. M. A. E.

965. *Calculation of the Perihelion Motion of Mercury from the Einstein Theory of Gravitation.* **P. Lazarsfeld.** (Zeits. f. Physik, 35. 2. pp. 119–128, 1925.)—This mathematical paper considers the classical problem of the perihelion motion of Mercury from the standpoint of the Einstein theory. In § 1 the author discusses briefly the formula for the perihelion motion, while § 2 deals with the general ds^2 of the field of a central body and the arbitrary functions involved. In § 3 is considered the conclusion of v. Gleich as to the arbitrary character of the perihelion formula to a first approximation, which conclusion is shown in § 4 to be invalid, the perihelion formula being established as invariant under these conditions. In § 5 is investigated the problem arising when the invariance of the perihelion formula is considered for any degree of approximation. The connection with the real period of an elliptic function is then derived. In § 6 the ambiguity of the perihelion formula, due to the impossibility of establishing the ds^2 by present astronomical observations, is discussed, while § 7 is devoted to calculations based on these considerations. In § 8 the consequences are derived from the fact that the Einstein formula is not invariant. Apart, however, from the question as to whether the planetary movements have to be treated as non-Euclidean, it is opined that the present state of accuracy of our observations renders the perihelion motion of Mercury no argument for or against the Einstein theory of gravitation. H. H. Ho.

966. *The Tensor of the Einstein Field and the Relativity Perihelion Formula.* **G. v. Gleich.** (Zeits. f. Physik, 35. 7. pp. 499–510, 1926.)—Lazarsfeld's recent paper on the calculation of the perihelion motion [see preceding Abstract] is discussed and the problem considered anew as to whether the tensor equations of the Einstein gravitational field condition a definite perihelion formula. A negative conclusion is again drawn as in a previous investigation [see Abstract 41 (1925)]. The paper also contains some observations for the purpose of elucidating the essential content of the general relativity theory. H. H. Ho.

967. *The Atmosphere of Mars.* **D. H. Menzel.** (Astrophys. J. 63. pp. 48–59, Jan., 1926.)—The appearance of a planet depends on the selective absorption and scattering of its atmosphere. Using the known values of the visual and photographic albedos, it is possible to evaluate the maximum quantity of atmosphere which Mars possesses. The amount per unit surface is not greater than one-fifth that above the earth. Under the lesser gravity, the corresponding pressure will be less than 5 cm. of mercury—equivalent to the pressure in the terrestrial atmosphere at a height of 18 km. The foregoing amount of atmosphere is insufficient to account for the appearance of Wright's photographs (Astron. Soc. Pacific Publ. 36. 234, 1924), which showed no detail in the ultra-violet, but strong contrast in the red. This is probably a characteristic of the material which composes the planet. The Martian polar caps are not an atmospheric but a surface phenomenon. Their relative prominence in the two pictures is due mainly to the difference in visual and photographic albedos. The greenish colour of Uranus and Neptune are due to the absorption by their atmospheres of the red end of their spectra.

AUTHOR.

968. *Polarisation of Venus.* **B. Lyot.** (Comptes Rendus, 182. pp. 266–269, Jan. 25, 1926.)—A continuation of polarisation observations ending May, 1922 [see Abstract 794 (1924)], and including the three epochs between successive conjunctions, Feb. 8, 1922–Nov. 24, 1922–Sept. 10, 1923–July 1, 1924. They show a variation with the illumination conditions, following a regular law. A figure is given whose abscissæ are the angles of diffusion (*circa* 2° to 176°), defined by the angular distance between earth and sun as seen from Venus. The daylight (compensated for atmospheric polarisation) and night observations during the three periods form a sixfold series, intermingled, but all clinging closely to the same curve, and thus indicating that the different sides of the planet are always (unlike Mars) sensibly of the same physical constitution. The author explains the polarisations of Venus by a comparison of those given by droplets of water, the curve of Venus resembling that formed by droplets whose diameters are constant and about 4·5 μ, obtained through the expansion of moist air in a balloon. The two curves present a similarity (except for small angles of diffusion, as yet unexplained) such as has not been found with that of droplets of other sizes or substances—solids, powders, mists, or smokes.

A. S. D. M.

969. *Sunspot Temperature.* **V. Bjerknes.** (Comptes Rendus, 182. pp. 48–50, Jan. 4, 1926.)—Considering a fluid medium with a free surface, and supposing that its density increases downwards more rapidly than is accounted for by compression, then if the medium has gaseous properties, its temperature must increase downwards more slowly than according to the adiabatic law. Considering in this medium a horizontal vortex, it produces in the free surface a depression D. The circulation round the vertical axis must be greatest at the surface and decrease downwards to a depth H, where it becomes nil. H thus represents the thickness of the vortex. The excess of circulation in the upper strata gives an excess of centrifugal force in the upper parts of the vortex. It acts like a centrifugal pump. Heavy masses are raised till their weight balances the centrifugal effect. Given the distribution of the velocities, the distribution of the masses which produces this equilibrium can be calculated. If the medium be gaseous, by the equation of gases the corresponding distribution of temperatures is arrived at, which will show a fall of temperature in the central parts of the vortex. At the lowest point of the vortex centre the depression D is below the level of equilibrium, and there is a corresponding temperature depression $\Delta T = T - T_0$. Supposing that the inclination of the free surface is small and that the velocity diminishes from the surface to the depth H, then if the depression ΔT be small compared with the absolute temperatures T_0 and T, it can be calculated by the formula $\Delta T = 2TD/H$. In the case of greater temperature depressions the more exact formula $\log_e T/T_0 = 2D/H$ is used. The temperature depression is thus a very simple function of the ratio between the vortex depression D and the thickness H. By applying this to a vortex on the sun's surface and introducing T = 6000°, the following temperature depressions are found :—

D/H	0·001	0·01	0·1	0·2	0·3	0·4	0·5
ΔT	12°	120°	1100°	2000°	2700°	3300°	3800°

The low temperatures of sunspots are thus explained and, according to this explanation, are analogous with those of terrestrial cyclones. E. F.

970. *Determinations on Internal Dense Solar Nucleus and on Movements of Spots in Latitude.* **E. Belot.** (Comptes Rendus, 182. pp. 119–121, Jan. 11, 1926.)—The author had suggested [see Abstract 1254 (1922)] that spot movements in latitude are due to the pulsation of a dense solar nucleus of constant volume, and that this should produce a periodic variation of the polar diameter. Armellini has published results of measures of horizontal diameters from 1877–1900, which give a periodic variation in accord with the solar cycle. The author assumes a nuclear density of 1·64, covered by an atmosphere (of 65,800 km. thickness) of feeble density (about 0·47), and the meteorology of the latter should, of itself, explain how the regular pulsation of the nucleus should, at the surface, be translated into the marked irregularities shown in the cycle. The vortices originating on the nucleus at the equator, and spreading northward and southward, must show a discontinuity in latitude at the surface. The rotation of the nucleus is taken as of about fifteen days, and the nucleus as pulsating at the solar equator to a distance of 35,000 km. Two diagrams are given to explain. It is stated that an increase of 1 in 100 in the equatorial atmosphere would suffice for the observed acceleration of the perihelion of Mercury. A. S. D. M.

971. *Physical Nature of Solar Corona. Part III.* **W. Anderson.** (Zeits. f. Physik, 35. 10. pp. 757–775, 1926.)—Continues the work of a previous paper [see Abstract 58 (1926)]. The distribution of luminosity in an adiabatic corona of pure electronic gas and in a corona formed of an electrically neutral mixture of electrons and protons is calculated. The result of the former calculation is found to agree very well with observation, whilst the later calculation is quite irreconcilable with observation. The radiation pressure and energy distribution in the photosphere is also considered. The original paper should be consulted.

W. H. Ge.

LIGHT.

972. *The Nature of Light.* **G. N. Lewis.** (Nat. Acad. Sci., Proc. 12. pp. 22–29, Jan., 1926.)—The author advances a new theory of the mode of transmission of light, based on the following postulates: (1) When an emitting atom loses energy of the amount $h\nu$, a particle with the same energy, the momentum $h\nu/c$ and the mass $h\nu/c^2$ may be regarded as travelling from the atom by a definite path until absorbed by another atom. The particle travels in a straight line, except in the immediate neighbourhood of material particles, and in each encounter the two obey the simple laws of conservation of energy, mass and momentum. (2) The phenomenon of interference does not become less marked as the intensity of light becomes feebler, so that the emission of a single light particle from a single atom is subject to the laws of interference. If the light from a certain source produces light and dark interference bands on a photographic plate, and the source is replaced by one in which the individual atoms emit their particles of light only rarely, these particles will appear on the plate only where the bright bands formerly were, and their number on different parts of the plate will be proportional, on the average, to the former intensity of illumination. From these it is argued that the phenomenon of interference is in some measure independent of the act of transition, and perhaps exists at times when there is no transfer of light from one atom to another. It is suggested that an atom never emits light except to another atom, the idea of mere emission being replaced by one of transmission. T. H. P.

973. *Diffuse Reflection of Light.* **G. I. Pokrowski.** (Zeits. f. Physik, 35. 1. pp. 34–37, 1925.)—Continuation of Abstract 521 (1925). Reflection from internal layers is now considered and some corrections deduced, which corrections are confirmed by experiment. A. D.

974. *The Relation of Visual Acuity and Accommodation to Ametropia.* **W. Swaine.** (Optical Soc., Trans. 27. 1. pp. 9–25; Disc., 25–27, 1925–1926.)—The author has previously published a theoretical table showing how degrees of ametropia affect visual badness (*i.e.* inverse of acuity). This paper is concerned with the comparison of artificially produced results on his own eye, of statistical figures, etc., with the theoretical table. An attempt is made at the same time to isolate the portion of the astigmatic pencil used in letter vision in astigmatic defects, with and against the rule, by using apparent accommodative esophoria as indicator. Published work by the author in the same connection, and hitherto not indexed, is also collected. AUTHOR.

975. *Theory of the Angle Prism.* **E. Daseke.** (Zeits. Instrumentenk. 46. pp. 10–15, Jan., 1926.)—The course of the rays through an isosceles right-angled prism is assumed to be known. The following investigation considers only those rays of homogeneous light of a plane which, after birefraction and bireflection, so emerge that the ingoing and the outcoming rays intersect each other. They then always meet at a right angle. The apex of this right angle—*i.e.* the point of intersection of the rays before the first and after the second refraction—shifts its position in a plane perpendicular to one of the edges of the prism. Whereas according to previous constructions the boundaries of the area in which the foot of the perpendicular can fall on a line of measurement consist of two analytical curves, it is here shown by analysis and geometry to consist of five parts of three curves of the sixth order. The treatment is entirely mathematical. E. F.

976. *The Control of Optical Surfaces.* **G. Yvon.** (Rev. d'Optique, 4. pp. 8–23, Jan.; 129–160, March; 180–210, April; 345–377, Aug.; 401–426, Sept., and pp. 593–611, Dec., 1925.)—In the series of papers a nomenclature is adopted for the different profiles used in the control of optical surfaces. The deformation of a spherical wave passing through a system is considered, knowledge of which indicates the optical defects of the system and material defects of the surface. The disposition of planes tangential to this emerging wave is taken and several applications of this fact made to the study of aberration. Geometrical methods are then examined to study the diffraction patterns produced by various systems. These tests are necessary to get a complete knowledge of the properties of system and the means of improving it. Finally a numerical classification is adopted which can characterise sufficiently well the degree of technical perfection obtained. This leads to a definition which takes account of the astigmatism of the system. These methods have been found of considerable assistance in the industry dealing with photographic objectives, but they are not adaptable to a severe control of astronomical systems. R. S. R.

977. *The Vergency Effect on Spherical Aberration as a Function of the Parameters in Certain Classes of Telescope Objectives.* **G. W. Moffitt.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 47–51, Jan., 1926.)—As deductions from theory regarding this effect have led to somewhat contradictory results, the author calculates the effect for a few selected objectives and determines the nature of the relationships from the results. Curves show the vergency effect for (1) a coma-free series, (2) a series corrected for spherical aberration with either side facing a distant object, (3) an intermediate series showing reduced vergency effect. These show that in field-glasses and the like for outdoor work the differences in the various objectives are relatively unimportant. For an instrument to be used at shorter distances, also, suitable choice of glasses and a proper form of objective are necessary to get the best definition over an extended field of view. R. S. R.

978. *New Intensimeter for Ultra-violet Rays.* **A. Gyemant.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 65–68, Jan., 1926.)—The method is based on the photometrical measurement, by comparison with a standard intensity, of visible fluorescent radiation produced by ultra-violet light in certain substances, the latter being mixed in varying proportions with suitable inert "fillers." It is shown that the intensity is given by the reciprocal of the concentration of the active substance. Anthracene is found to be the most suitable fluorescent substance, talc being used as the inert filler. The standard brightness is produced by a circular screen of ZnS containing a radium salt, and is arranged in the apparatus so as to be viewed concentrically surrounded by the screen to be viewed, in the form of an annulus. A system of filters is described for cutting off all visible rays emitted by the quartz lamp employed. A. B. C. L.

979. *Primary Spherical Aberration.* **(Miss) H. G. Conrady.** (Phot. J. 66. pp. 9–25, Jan., 1926).—An experimental study of the effects of varying amounts of the aberration which causes longitudinal differences of focus for outer zones of a lens system which are proportional to the squares of the diameters of those zones. The work was carried out on a lens afflicted with practically pure primary spherical aberration whilst almost entirely free from any other kind of aberration, and the results refer to the effects of relatively large amounts of spherical aberration amounting to many multiples of the Rayleigh limit, such as occur almost without exception in photographic objectives. W. H. Ge.

980. *The Interferometer Patterns due to the Primary Aberrations.* **R. Kingslake.** (Optical Soc., Trans. 27. 2. pp. 94–102; Disc., 102–105, 1925–1926.)—In order to obtain a rapid estimate of the quality of a lens by observing its behaviour in the interferometer, it is necessary for the observer to be familiar with the characteristic patterns of the various primary aberrations under various conditions of adjustment. A method is described by which these patterns can be easily calculated for any required case; and series of typical patterns are shown together with actual interferograms for comparison. Author.

981. *Application of the Michelson Stellar Interferometer to the Measurement of Small Particles.* **U. Gerhardt.** (Zeits. f. Physik, 35. 8–9, pp. 697–717, 1926.)—It is shown that with the microscope as with the telescope the resolving power of an objective is doubled by interference observations. The lower limit of the field of measurement for a few objectives is given in a table. A quarter of the wave-length employed is reckoned as being theoretically the smallest distance measurable by the method. By employing immersion systems of 1–3 numerical aperture it is thus, according to the theory, possible to determine particles of 106 $m\mu$ in diameter, taking $\lambda = 0 \cdot 55\ \mu$. The observations were made with small particles (Hg and mastic) in the dark field of a Zeiss cardioid or paraboloid condenser. The diameters of the particles measured lie between $1 \cdot 5\ \mu$ and $0 \cdot 38\ \mu$. There is close agreement with the direct measurements. Further investigations carried out with a V slit of variable breadth show the smallest hitherto measured particle to have a diameter of $0 \cdot 24\ \mu$, this being determined with an objective of 0·65 numerical aperture and 1·5 mm. normal free object distance. The smallest distance practically measurable with an objective is found to be about 10 % above the theoretical lower limit of its field of measurement. On the basis of the radial polarisation of the refracted light of the particle a modification of the method is suggested whereby the equidistance of the interference maxima may be adjusted in the "first Wollaston image." Tables are given of lenses employed and measurements effected. E. F.

982. *Lower Limit of the Michelson Stellar Interferometer Method of Measurement.* **O. v. Baeyer and U. Gerhardt.** (Zeits. f. Physik, 35. 8–9. pp. 718–719, 1926.)—It is shown that, apart from the arrangement of the double slit, the resolving power of the interference microscope is always limited by the numerical aperture of the observation objective. The working is mainly mathematical. E. F.

983. *"Peristereoscopic" Images.* **G. Bessière.** (Comptes Rendus, 182. pp. 208–210, Jan. 18, 1926.)—By means of an opaque screen furnished with vertical slits it is proposed to represent on a single plane surface the various aspects presented by an object when the position of the spectator is shifted horizontally between two limits, thus realising the Lippmann-effect in a horizontal direction and producing the impression of relief. To follow out all the details of the author's method the drawings in the original paper should be consulted. E. F.

984. *A Spectro-polarimeter for the Ultra-violet.* **A. Cotton** and **R. Descamps.** (Comptes Rendus, 182, pp. 22–26, Jan. 4, 1926.)—An apparatus is described whereby the rotation of the analyser produces a trace on a film mounted on a cylinder concentric with the axis of the instrument. This can be effected by reflecting the beam at right angles; but by using a refracting prism of calcite as analyser, and supplementing it with a refracting prism of quartz, the light can be refracted instead of being reflected on to the film. Each spectrum line then produces on the film a separate trace, which disappears at the position of extinction. If the polarimeter contains a substance which exhibits marked rotatory dispersion, the course of the dispersion can be followed by noting the position of the point of extinction on the traces produced by successive spectrum lines. T. M. L.

985. *Testing, Efficiency and Properties of Optical Gratings.* **L. C. Glaser.** (Zeits. techn. Physik, 7. 1. pp. 31–42, 1926.)—The demand for accurate gratings for technical spectrum analysis necessitated the investigation of the various gratings which are in use. Fourteen gratings were examined microscopically and photographed so that the quality of the rulings could be determined. In this way the various errors of the rulings were investigated. A method of testing the gratings was developed, based upon the microscopical examination of the rulings. The control of the manufacture of gratings and reduction of errors due to imperfections in the diamond points and the material was investigated and improved. The properties of speculum metal for making gratings were examined, and the effect of the structure of the metal upon the qualities of the gratings was determined. The development of the structure during ruling was proved. F. J. B.

986. *Spectrograph using a Non-inclined Plate.* **P. Sève.** (Comptes Rendus, 182. pp. 57–58, Jan. 4, 1926.)—A description of an arrangement enabling an ultra-violet spectrum to be obtained using a concave mirror and easily procurable quartz lenses and prisms and obviating the use of expensive achromatic quartz lenses. A beam of light from a slit, after reflection at a concave mirror, is rendered parallel by a diverging lens, falls on a quartz prism, and is eventually brought to a focus on a plate placed perpendicularly to the beam. A platinised glass mirror of 150 cm. radius and a quartz lens of 45 cm. focal length and 2·5 cm. diameter gave sharp photographs of a copper arc in the region 5782 to 1979 Å.

W. V. M.

987. *The Fabry and Perot Parallel Plate Étalon.* **W. H. J. Childs.** (Journ. Sci. Instruments, 3. pp. 97–103, Jan., and pp. 129–135, Feb., 1926.)—A concise account is given of the theory and use of the instrument, together with descriptions of the customary arrangements of apparatus and the methods of étalon adjustment. An approximate expression for resolving power is deduced; values obtained with it are tabulated and shown. Details are given of a photographic method of finding the reflecting power of the metallic films of the étalon. If it is desired to use the instrument in the infra-red or ultra-violet, combinations other than silver films on glass must be used. A list of such combinations is given, with the region for which each is best suited. Finally, as an aid to comparison, some of the most important properties of the étalon, Lummer plate and echelon are gathered together and tabulated. AUTHOR.

988. *The Dispersion of the Optical Constants of Mercury.* **B. O'Brien.** (Phys. Rev. 27. pp. 93–98, Jan., 1926.)—Measurements were made on clean mercury surfaces prepared by the method of Röntgen as used by Wheeler. The optical constants were determined for the range 4358 to 3022 Å., using the method of Jamin. Light from a mercury arc was dispersed by a quartz spectroscope of the Littrow type with a fused silicon mirror to reduce scattered visible light, and a phosphorescent screen or fluorescent solution was used in making the readings. The results for refractive index n, absorption coefficient nk and computed percentage reflectivity R at normal incidence are as follows:—

	4358	4047	3650	3130	3022
n	0·88	0·79	0·64	0·44	0·55
nk	3·47	3·40	2·97	2·53	2·25
R	77	78	78	79	70

The beginning of a region of transparency is apparently indicated at 3022 Å. AUTHOR.

989. *Photoelectric and Optical Measurements on Blue and Yellow Rock-salt.* **Z. Gyulai.** (Zeits. f. Physik, 35. 6. pp. 411–420, 1926.)—Curves are given for the absorption coefficients of blue and violet rock-salt over the range from 2500 to 7500 Å.U. and for the electrical conductivity produced by the *absorption* of equal quantities of light of different wave-lengths. In the blue crystals the maximum effect is at 3150 Å.U., as compared with 3400 Å.U. for the surface photoelectric effect on metallic sodium; in the violet crystals there are two maxima, at 3150 and 4150 Å.U., the second being perhaps due to potassium, since this metal gives a maximum photoelectric effect at 4400 Å.U. [See Abstract 367 (1926).]

T. M. L.

990. *Method of Estimating Coloured Gases, using the Photoelectric Pile.* **H.** and **A. Copaux.** (Comptes Rendus, 181. pp. 1058–1060, Dec. 21, 1925.)—The photoelectric pile of alkaline metals forms a very sensitive and impersonal photometer, and is considered superior to the spectro-photometer in the measurement of absorption of light. A tube containing a mixture of air and nitrogen peroxide is placed between a constant luminous source and the pile, and the quantity of light transmitted is measured in terms of the deflection of a very sensitive galvanometer. The amount of oxide of nitrogen is determined chemically, and its variation is plotted with the galvanometer deflection. Another curve shows the variation of absorption with concentration. G. E. A.

991. *Diffraction of Light from a Wide Source.* **F. Wolfers.** (J. de Physique et le Radium, 6. pp. 305–312, Oct., 1925.)—The summationcurves for the fringes produced by a luminous band and a straight edge parallel to it, worked out graphically. Generally, only the first maximum remains clear always; the first minimum mostly appears, and if it does it is very distinct. The first maximum is always beyond the penumbra; the intensity increases regularly and continuously throughout the penumbra; the distances of the maxima and minima from the edge of the penumbra are not constant. Experimental verifications. Certain new fringes were also observed, not predicted by the theory. The intensities at the edge of the shadow tend to a limit as a breadth of the source is increased. Certain applications suggested. A. D.

992. *Interference by Diffusion.* **F. Wolfers.** (J. de Physique et le Radium, 6. pp. 354–368, Nov., 1925.)—A study of the supplementary fringes mentioned in an earlier article [see preceding Abstract]. These require a wide source; if it be narrow, they are masked by diffraction. Their distances from the edge of the shadow are approximately proportional to the square roots of odd numbers. They are due to interference between waves from (*a*) a narrow strip of the source near the end which determines the geometrical boundary of the shadow, and (*b*) a secondary source at the edge of the screen. The surface of the screen must be covered with resonators of relatively long period, which absorb by quanta the radiant energy received under a grazing incidence and re-emit spherical waves, which illustrates and confirms Bohr's ideas as to diffusion. The diffused waves have phase-relations with the incident light. The privileged position of the strip (*a*) above limits the possible arrangements of the resonators; the incident rays must make with the surface of the edge of the screen (which need not be a knife-edge) an angle not exceeding 40° for the violet. The resonators are definitely oriented with respect to the screen. Certain phenomena of X-rays are explained by these observations, which tell against their being explained by luminous projectiles. A. D.

993. *Molecular Diffusion of Light in Isotropic Solids.* **R. Gans.** (Univ. Nac. La Plata, Estudio Ciencias, Ser. Mat. Fis. No. 67. pp. 443–449, Aug., 1925.)—Einstein worked out this problem [see Abstract 815 (1911)], and by suppressing δ', the variation of the optical dielectric constant with change of form at uniform volume, and K, the modulus of torsion, arrived at certain results not in accord with experiment. The author starts with the same assumptions as to the fluctuations of position of the elements of mass of a continuous elastic solid, and by rigorously working out, and only finally dealing with limiting cases, arrives at results in accord with experiment. A. D.

994. *Calculation of Verdet's Constant in the Molecular Theory.* **R. de Mallemann.** (Comptes Rendus, 181. pp. 1139–1141, Dec. 28, 1925.)—An equation is deduced whereby the magnetic rotatory power of a compound can be calculated from its refractive power, *e.g.* for the sodium line

$$\Lambda = 15\cdot82 \times 10^{-7}\,\frac{M}{d}\,\frac{(n^2-1)^2}{n}$$

The numerical verification depends on a knowledge of the number of effective electrons. In a series of twelve aliphatic compounds this appears to be always four less than the total number of valency electrons; for a benzene nucleus it is fourteen less; but in both cases there is a normal increment of six on replacing hydrogen by halogen. [**Errata** (*ibid.*, 182. p. 732, March 15, 1926).] T. M. L.

995. *A Case of Mutarotation. Saponification of Ethyl Oxalate by Water and by Dilute Acids.* **E. Darmois.** (Comptes Rendus, 181. pp. 1137–1139, Dec. 28, 1925.)—The hydrolysis of ethyl oxalate can be followed by noticing the changes of rotatory power which are produced by the action of the liberated oxalic acid on dextrorotatory ammonium molybdomalate, which is thereby converted into a lævorotatory product. T. M. L.

996. *Molecular Structure and Optical Anisotropy.* **K. R. Ramanathan.** (Roy. Soc., Proc. 110. pp. 123–133, Jan. 1, 1926.)—In a previous paper a theory was advanced that optical anisotropy can be attributed to the mutual reactions of the doublets induced in different atoms of the molecule by the incident radiation [Abstract 1856 (1925)]. In this paper the optical anisotropy of benzene and cyclohexane is considered. Reliable estimates of the imperfection of polarisation of the light scattered by these substances from a plane polarised ray are compared with the theoretical values obtained on various assumptions as to the form of the benzene ring, the orientation of the hydrogen atoms and the values of the atomic refractivities. If the carbon atoms in benzene lie in a plane regular hexagon, as in graphite, the anisotropy is too high even if the effect of the hydrogen atoms is neglected. With the carbons in a puckered ring, as in diamond, and the hydrogens joined to the carbons at the tetrahedral angle, the molecular anisotropy agrees well with observation if the atomic refractivities are taken as those of diamond and gaseous hydrogen. The molecular refractivity also agrees well with theory. The theory is then applied to cyclohexane, the hydrogen atoms being supposed to be situated alternately on each side of the median plane of the carbon ring. Calculation shows a greatly decreased optical anisotropy, which is closely borne out by experiment. The form of the glass vessel employed for investigating the scattered light from substances which require heating is shown. It is pointed out that single anisotropic molecules have principal refractive indices far further apart than those of solid doubly refracting substances. For instance, the principal refractive indices of potassium nitrate are in the ratio 1·19 : 1, while a benzene molecule has the corresponding ratio 2·45 : 1. A. Wh.

997. *The Kerr Constant.* **W. Ilberg.** (Phys. Zeits. 26. pp. 901–908, Dec. 31, 1925.)—The determination of the constants of electro-optical double refraction in optically active substances sets up in general the applicability of the formulæ of Gouy (J. de Physique, 4. 149, 1885) and Weiner (Wied. Ann. 35. 1, 1888) even for the case where the double refraction happens to be caused by an electric field. This is confirmed by measurements on CS_2, in which a rotation is simultaneously produced by a magnetic field (Faraday-effect). In some substances (*e.g.* amyl bromide) it is possible to compensate the natural rotation by an imposed Faraday-effect, and then to measure the Kerr constant by the ordinary methods. A. D.

998. *Magnetic Rotatory Power at Low Temperatures.* **H. K. Onnes, J. Becquerel and W. J. de Haas.** (Comptes Rendus, 181. pp. 838–841, Nov. 30, 1925.)—J. Becquerel found [see Abstract 1424 (1908)] that certain minerals containing didymium (tysonite, parisite) presented a magnetic rotatory power varying, from laboratory temperatures to the temperature of liquid air, inversely as the absolute temperature, which suggested that the magnetic rotatory power was proportional to the susceptivity. These observations now extended down to the boiling-point of liquid helium (4°·2 abs.). It appears that magnetic rotatory power is due to two causes, acting in contrary senses: (*a*) positive, by the Zeeman-effect for the radiations absorbed; (*b*) negative, through a dissymmetry of intensities in the absorption of circular vibrations of opposite sense, caused by a phenomenon of orientation or of distortion in the field. A. D.

999. *Polarisation of Radiation excited by Electron Impact.* **A. Ellett, P. D. Foote** and **F. L. Mohler.** (Phys. Rev. 27. pp. 31–36, Jan., 1926.)—If a unidirectional beam of electrons, of velocity slightly in excess of the resonance potential, is projected through a vapour at a very low pressure so that effects due to atomic collision and resonance radiation are negligible, and in the absence of an applied field and resulting Larmor precession, there is reason to suspect that the radiation emitted perpendicular to the electron beam should be partially polarised, especially for lines corresponding to $\Delta j = 1$. Experiment showed a polarisation of about 30 % for λ2537 with the greatest intensity of the electrical vibration having a direction perpendicular to the electron beam. No polarisation was detected for the unresolved sodium D-lines, confirming the recent observation of Kossel and Gerthsen [see Abstract 2481 (1925)]. A field of 3 gauss parallel to the electron beam produced no effect. With the field perpendicular to the beam the radiation along the field was unpolarised, while that perpendicular to the field was reduced in polarisation to 13 %. These results suggest that the atom radiates with the same distribution of polarisation and intensity as in a zero field, but with the atom rotated through an angle determined by the time of excitation and the precessional velocity. AUTHORS.

1000. *Brewster's Bands. Part I.* **C. V. Raman** and **Sushil Krishna Datta.** (Optical Soc., Trans. 27. 1. pp. 51–55, 1925–1926.)—The paper considers the explanation of Brewster's bands and other allied phenomena from the new and very suggestive standpoint proposed by Schuster [Abstract 2949 (1924)]. When monochromatic light is reflected by or transmitted through two parallel plates in succession, we have a superposition of the Haidinger ring-systems, due to the two plates in the sense that the observed intensity in any given direction is the product of the intensities due to either plate separately. Illustrations showing the effect of such superposition in various cases are reproduced with the paper, differential and summational fringe-systems of various orders being observable. When non-homogeneous light is used, the Haidinger rings disappear and along with them also the superposition pattern, leaving only a uniform illumination in the field, except in the special case of the differential system of the first order for two plates of equal thickness. A simple geometrical explanation is thus forthcoming why Brewster's bands can be observed even in non-homogeneous light with thick plates in this case. AUTHORS.

1001. *Heterochromatic Photometry.* **C. Schaefer.** (Phys. Zeits. 26. pp. 908–913, Dec. 31, 1925.)—A continuation of previous work [see Abstract

1076 (1925)] demonstrating the validity of heterochromatic photometry and its conformity with Schrödinger's condition. J. W. T. W.

1002. *A Trichromatic Colorimeter Suitable for Standardisation Work.* **J. Guild.** (Optical Soc., Trans. 27. 2. pp. 106–128; Disc., 128–129, 1925–1926.)—The paper describes a trichromatic colorimeter designed and constructed in 1922. The instrument is suitable for standardisation work, as it may be employed to obtain the specification of any colour whatever in a form which may be converted if desired to any fundamental basis of specification. The three working primaries of the instrument are obtained by means of filters. The mixing of the primary colours is effected by a periscopic prism which rotates past three stationary sectors. Provision is made for adding any of the primaries to the colour under test, where this may be necessary in order to obtain a match. In this way colours of higher saturation than it is possible to match directly may be dealt with. AUTHOR.

1003. *A Criticism of the Monochromatic-Plus-White Method of Colorimetry.* **J. Guild.** (Optical Soc., Trans. 27. 2. pp. 130–136; Disc., 136–138, 1925–1926.)—The author contends that, from the practical standpoint of quantitative colorimetry, hue and saturation are not the fundamental elements of colour quality, but must be regarded merely as derivatives of the trichromatic constitution of the colour. Practical and theoretical reasons are advanced to show that whatever may be the advantage of specifying colour quality by hue and saturation, there are grave objections to practical methods of colorimetry involving the direct measurement of saturation. AUTHOR.

1004. *A New Method of Colorimetry.* **J. Guild.** (Optical Soc., Trans. 27. 2. pp. 139–155; Disc., 155–158, 1925–1926.)—The paper describes a new method of determining the quality of a colour, as defined by its position on the trichromatic colour chart, in which only the colour-matching properties of the eye are involved. The determination depends on two colour matches in each of which the test colour is matched by a mixture, in unknown proportions, of a standard colour and a monochromatic colour obtained spectroscopically, a different standard colour being used for the two matches. An instrument is described in which the method is embodied [see also preceding Abstract]. AUTHOR.

1005. *Scattering Coefficient of Some Saturated Vapours.* **S. Ewing.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 15–26, Jan., 1926.)—Deals with the measurement of the light-scattering coefficient of the saturated vapours of ether, benzol, chloroform, ethyl alcohol and methyl alcohol at a definite temperature. A locomotive headlight was used as a source, and the intensity of the incident light was compared with the intensity at right angles to the incident beam by a photographic method. The results are found to agree with those calculated from theory within the limits of experimental error, and they give the number of molecules per cubic centimetre under standard conditions as $(2\cdot69 \pm 0\cdot03) \times 10^{19}$. W. H. GR.

1006. *Scattering in Coarse Media.* **G. P. Woronkoff and G. I. Pokrowski.** (Zeits. f. Physik, 35. 8–9. pp. 633–641, 1926.)—An experimental method is described by which measurement can be made of the intensities of the light scattered in different directions by an optically heterogeneous substance. An empirical law is established of the relation between the intensities of the light scattered in a given direction and the optical properties of the scattering substance, and this law agrees with the observations. The law is also consistent with the assumption that the deviation of a ray from the original direction is proportional to the length of its path in the medium. **W. H. Ge.**

1007. *The Lummer-Gehrcke Plate.* **E. Gehrcke.** (Ann. d. Physik, 78. 5. pp. 461–464, Dec., 1925.)—Combats van Cittert's conclusions [Abstract 2703 (1925)]. **A. D.**

1008. *General Principles of Photographic Surveying.* **H. S. L. Winterbotham.** (Optical Soc., Trans. 27. 2. pp. 65–73, 1925–1926.)—The paper gives a brief outline of the development of photogrammetry from terrestrial and aerial positions and an indication of some of the points to be considered in the design of instruments required by the photogrammetric surveyor in this country. **Author.**

1009. *Perspective Conditions of Photogrammetry.* **M. N. MacLeod.** (Optical Soc., Trans. 27. 2. pp. 74–83, 1925–1926.)—The perspective conditions which must be satisfied in aerial survey work are discussed and the methods of reconstructing these conditions from the photographs obtained are described. Attention is drawn to the desirability of designing new apparatus with which to carry out the necessary reconstruction with the requisite accuracy. **Author.**

1010. *Some Precision Problems in Air Survey.* **M. Hotine.** (Optical Soc., Trans. 27. 2. pp. 84–89; Disc., 89–93, 1925–1926.)—The various factors upon which accuracy in air survey measurements depends are described, and suggestions are made as to some of the conditions which should be fulfilled in apparatus employed for such measurements. **Author.**

1011. *An Instrument for the Rapid Production of Laue Photographs.* **J. T. Norton.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 27–29, Jan., 1926.)—A description of a small instrument to obtain Laue photographs with exposures of a few minutes. The pinhole system consists of a brass plate ½ in. thick screwed to a base, the hole having a diameter of 0·028 in. (No. 70 drill). The arrangement described is an attachment for a standard G.E.C. apparatus. Dental plates are used, and exposures of five to ten minutes suffice in the case of good crystals for the production of Laue photographs with a water-cooled molybdenum tube. **W. V. M.**

1012. *Intensity Measurements in Band-Spectra.* **R. Sewig.** (Zeits. f. Physik, 35. 7. pp. 511–523, 1926.)—Dorgelo has developed a method of photographic photometry independent of certain errors, and the method has been adapted by Frerichs to measurements in the ultra-violet region and the use of concave gratings. Some sources of error in the usual methods when applied to intensity measurements in band-spectra are discussed by the author, particularly such errors as are likely to arise from the non-resolution of lines near the head of the band. It is shown that in certain cases the error may be as large as 10 %. A description is then given of results obtained in measurements of the cyanogen band 3883 under different conditions of excitation. With decreasing pressure, as well, presumably, as decreasing temperature, the intensity maximum of the P branch moves to smaller current numbers. Previous results by Haferkamp are qualitatively correct except in the neighbourhood of the heads, where the error previously discussed becomes important. The dissymmetry of the intensities is not certain in the case of 3883, but for 4216 the R branch is stronger. The negative nitrogen band (3914) was also investigated, with the following results: A dissymmetry exists between the intensities of the P and Z branches, the former being always more intense. The ratio $P_{(m)} : R_{(m)}$ is not constant, but a simple function of m. A theoretical interpretation is attempted, following Dieke, it being shown that the formula deduced theoretically, $J = am^{*}e^{-Cm^{*2}}$, where $m^{*} = j$, is not correct. A formula of the type $a(m - c)e^{-C(m-d)^2}$ might suffice, but the physical significance of the constants is not clear. W. V. M.

1013. *An Arrangement for Photographic Spectrophotometry with Large Dispersions.* **R. Frerichs.** (Zeits. f. Physik, 35. 7. pp. 524–527, 1926.)—In the usual method the spectral lines to be investigated are photographed, using various absorbing screens, and the relative intensities calculated from the blackening curve of the plate obtained from microphotometric observations. A method is described in which the reductions in intensity are obtained by rotating screens of wire, and the method may be employed in conjunction with concave gratings. A system of vanes having slits in them rotate in front of the photographic plate, the rotation being effected by a cinema maltese cross geared to the rotating weakening screens. In this way different portions of a line are exposed to different extents. Comparison standard photographs may be made simultaneously. The paper should be consulted for details and diagrams. The method was employed by R. Sewig (see preceding Abstract). W. V. M.

1014. *Polarisation of Fluorescence-Light of Dyestuffs.* **P. Fröhlich.** (Zeits. f. Physik, 35. 3. pp. 193–206, 1925.)—Under equal viscosities of different solvents the degrees of polarisation are different. Freezing the solution does not alter the degree of polarisation. In some cases the pure solvent is fluorescent, and its fluorescence-light is also polarised. On stimulation with different wave-lengths, in all cases tried the degrees of polarisation are different. A. D.

1015. *Luminescence.* **Dorothy G. Engle** and **B. S. Hopkins.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 599–615, Dec., 1925.)—The cæsium cell, sensitive from 409·5 mμ to 718 mμ, furnishes a very convenient means for the accurate measurement of visible luminescence. The best sensitising agents for zinc sulphide are Mg, Cu, Mn; for calcium metaphosphate Mo, Neod, Erb; for zinc silicates Tha, Neod, ceric Ce, Columbium, Mo. In general, luminescence increases with decreasing amounts of the sensitising agent, although absolutely pure samples show no luminescence; the curve is not smooth, but periodic. Zinc metasilicate is more luminescent than the orthosilicate. Iron oxide has a deleterious effect on luminescence. Dry mixing or grinding is harmful after a certain amount; intimate mixture by solution is very favourable to luminescence. Luminescence increases rapidly at first with increasing time of fusion, then gradually becomes constant after about twenty-five minutes; it increases rapidly but regularly with increasing temperature of fusion up to about 1150° C., after which it remains constant. Compounds similar to zinc silicate all show more or less luminescence when excited by kathode-rays. Blue light produces phosphorescence best of those tried, then green, then yellow. Luminescent samples are semi-crystalline. The amount of luminescence that can be excited in samples decays rather rapidly for the first two or three days, and then gradually becomes constant. Colour of fluorescence is influenced by (*a*) nature of sensitising agent, (*b*) amount of sensitiser, (*c*) temperature of fusion, (*d*) time of fusion, (*e*) nature of the exciting agency, (*f*) atomic weight of base used. A. D.

1016. *An Investigation of the Stark-Effect in the Resonance Fluorescence of Mercury.* **W. Hanle.** (Zeits. f. Physik, 35. 5. pp. 346–364, 1926.) Polarisation is increased or diminished according to conditions: with strong fields the polarisation becomes in certain cases elliptical and partially decreased. This is not a Kerr-effect, but a Stark-effect during the process of fluorescence, which can be interpreted by means of a simple classical model. But other results cannot be so interpreted. A quantum theory will account for all the phenomena. According to this explanation there is a splitting up into π and σ components; it is only necessary to make the additional assumption that with small fields there is little or no quantising of the electric vector. Investigations in combined electric and magnetic fields show that the decisive factor in the polarisation is the *stronger* field. The explanation lies in the restrictions which control the direction quantising of either field. For this purpose the stronger field is that which brings about the greater frequency split. The Faraday-effect for the line 2536·7 was observed in fields up to a few gauss. A short mathematical supplement is given. [See also Abstracts 839 (1925), 2973 (1924).] J. E.

1017. *The Decay of Fluorescence of Dyestuff Solutions. Preliminary Communication.* **E. Gaviola.** (Zeits. f. Physik, 35. 10. pp. 748–756, 1926.)—A modification of the Abraham Lemoine arrangement [Abstract 1859 (1899)] for the investigation of the lag of the Kerr-effect is described. Gottling used a similar arrangement for the measurement of decay time of phosphorescence, and came to the conclusion that there was a lag between absorbtion and re-emission. His result can be also interpreted on the assumption of an instantaneous re-emission with an exponential decay, the measured times being the average decay times. The arrangement adopted permits of its use for a measurement of the time of decay of very short-lived phosphorescence of the order of 10^{-8} and 10^{-9} secs. Measurements were made of the time of decay of rhodamin and uranin in aqueous and in glycerin solutions under various conditions. It is found that an alteration of the concentration or temperature has very little effect on the decay time. The decay times for rhodamin are much shorter than those found by Gottling, and the possible explanation of the difference is discussed. J. E.

1018. *Average Life of the Active State of Fluorescent Molecules.* **F. Perrin.** (Comptes Rendus, 182. pp. 219–221, Jan. 18, 1926.)—In a previous note on the polarisation of fluorescence [see Abstract 1359 (1925)] the author has wrongly used as a definition of the amount of polarisation the expression $\rho = (Iz - Iy)/Iz$, which led to the formula $\rho = \eta/4(\eta + s)$, where $s = 5RT\tau/6\nu$, τ being the average life in the active state and $\nu = 4N\pi r^3/3$, the real volume occupied in solution by a gr. mol. of the fluorescent body. By taking the correct definition $p = (Iz - Iy)/(Iz + Iy)$, the expressions found for a circular oscillator become $p = \eta/7(\eta + s)$, with $s = 20RT\tau/21\nu$, the limiting maximum value being 1/7 instead of 1/4. Experimental data for the polarisation limits between 0·25 and 0·40 show that the hypothesis of a circular oscillator must be abandoned, but by utilising the formulæ previously obtained from the Brownian movement of rotation it is found that the form of the law of variation of the polarisation as a function of the viscosity η is general, whatever may be the nature of the oscillator assumed for the fluorescent molecule and the mode of excitation by the incident radiation, and that $p = p_0\eta/(\eta + s)$ with $s = (1 - p_0/3)RT\tau/\nu$, where p_0 is the observed polarisation. In general p_0 and τ are found to be independent of viscosity, but often dependent on the dielectric power of the solvent, and $\tau/\tau_0 = k$, where k is the amount of fluorescence in light quanta and τ_0 the value which the average life would have if the only cause of return to the normal state of the activated molecule was light emission. A formula is given for τ_0 based on the Einstein formulæ relating to the probability of passage from one stationary state to another, and experimental data for aqueous alkaline solutions of fluorescein are in satisfactory agreement with the theoretical value $\tau_0 = 0{\cdot}6 \times 10^{-8}$ sec.

H. H. Ho.

1019. *Relation between the Chemical Elements in Reference to the Effect of an Electric Field on their Line Series.* **J. Stark.** (Ann. d. Physik, 78. 5. pp. 425–433, Dec., 1925.)—The Balmer hydrogen series is given by the formula $1/\lambda = v = N(1/2^2 - 1/m^2)$, where $m = 3, 4, 5$, etc. This can be written $\nu = 2\omega - m\omega$. where $m = 3, 4, 5$, etc. For hydrogen there is only one value of $m\omega$ (one *Laufzahlreihe*), but for the other elements there are several values and hence several series of the second order. From the observations of Nyquist and Forster the author concludes that for a heavy element the following series of the second order ($2p$ series) exist, namely :—

Sharp series .... $v = 2p - ms$ $m = 3, 4 \ldots$
Nearly sharp series .... $v = 2p - mp$ $m = 3, 4 \ldots$
Diffuse series .... $v = 2p - ma$ $m = 3, 4 \ldots$
First nearly diffuse series ...... $v = 2p - mf_1$ $m = 3, 4 \ldots$
Second nearly diffuse series .... $v = 2p - mf_2$ $m = 3, 4 \ldots$

The values of $ms - mw$, $mp - m\omega$, $ma - m\omega$ are called the hydrogen-differences of the series lines, and the object of the author is to compare the Stark-effect with the hydrogen-differences. To this end he has compiled three tables for the first three of the above series. From an examination of these tables the following conclusions are drawn : In nearly all cases the hydrogen difference is positive and the Stark-effect $\Delta\lambda$ also positive. When the hydrogen-difference is negative the value of $\Delta\lambda$ is negative. When the hydrogen-difference increases, $\Delta\lambda$ decreases. For equal hydrogen-differences, the effect $\Delta\lambda$ decreases in order of sharp series, nearly sharp and diffuse series. An attempt is made to explain these results from a consideration of the electron structure of the atoms.

T. B.

1020. *Production of Ultra-violet Light by the Impact of Low-velocity Electrons on the Surface of a Metal.* **P. Bricout.** (Comptes Rendus, 182. pp. 213–215, Jan. 18, 1926.)—A description of experiments to produce ultra-violet radiation from a Pt target by kathodic bombardment. In order to obviate the difficulties of space charge and direct visible radiation from the filament, the latter is stretched along the axis of a fused silica cylinder and the anode of Pt situated in a radial plane passing through the axis of the filament and at a little distance from it. The filament and anode are surrounded by a cylindrical plate of molybdenum, which may be raised to a high potential. A magnetic field parallel to the filament curves the electronic paths and brings them into contact with the platinum plate, from which ultra-violet radiation of wave-length 2300 to 2100 Å. has been detected. Errors and difficulties of the experiments are considered.

W. V. M.

1021. *Coupling Possibilities of the Quantum Vectors in the Atom.* **S. Goudsmit** and **G. E. Uhlenbeck.** (Zeits. f. Physik, 35. 8–9. pp. 618–625, 1926.)—Pauli [Abstract 1875 (1925)] has shown that to every electron in an atom the quantum vectors R and K may be assigned, and that in the whole atom the resultants of the R's and K's may be determined. Other possibilities may arise, however, in atomic combinations, and different coupling arrangements are now discussed. The *g*-formulæ are derived where the different ramifications receive a simple interpretation in the neon spectrum, which is found to be a simple-triplet-triplet-quintet system. An appendix contains an interpretation based on the Compton hypothesis of the quantised rotating electrons. H. H. Ho.

1022. *Quantised Motion of a Diatomic Molecule.* **E. Hallén.** (Zeits. f. Physik, 35. 8–9. pp. 642–651, 1926.)—A mathematical paper in which an amendment is made to the derivation of the band-spectra of diatomic molecules, advanced by Kramers and Pauli on the basis of the Kramers molecular model [see Abstract 1395 (1923)]. It is shown that besides the rotation spectrum $\nu = h/(4\pi^2 A)\{m + \frac{1}{2} - \rho\}$ arrived at by Kramers and Pauli, another is permissible given by $\nu = h/(4\pi^2 A)\{m + \frac{1}{2} + \gamma\rho\}$; here m is the quantum number and γ varies with m in a given manner. The permissible values of m for the second series must have an upper limit, as otherwise the velocity of rotation about the molecular axis would become excessive. For values of m beyond this limit the Kramers and Pauli spectrum only would exist. Recent investigations of the band-spectrum of aluminium hydride by Eriksson and Hulten show that it displays the essential features of the spectrum considered here.

W. S. S.

1023. *Quantum Theory of Radiation.* **A. Landé.** (Zeits. f. Physik, 35. 5. pp. 317–322, 1926.)—As Bohr has pointed out, the quantum states of an atom cannot be regarded as mathematically sharp. The bearing of this lack of sharpness on the main postulate of the Bohr theory is discussed. The act of emission of a single atom is to be considered, not as a simple transition from one sharply defined state to another, but as a continuum of such transitions. This leads to the idea that the precise quantum state must be replaced by a continuous group of states through which the atom very rapidly passes, the relative time spent in each state being determined by the width of the spectrum line emitted when a transition is made to another similar group of states. W. S. S.

1024. *Some Studies of the Stark-Effect.* **C. E. Deppermann.** (Astrophys. J. 63. pp. 33–47, Jan., 1926.)—A method is described for obtaining the Stark-effect by using a long, thin kathode, the discharge being constricted between two parallel plates. The advantage derived in greatly increased light-intensity is found to be discounted by difficulties of construction, of sputtering, and especially of proper focusing. The Stark-effect obtained was of about the same order as that for a lo Surdo tube having diameter equal to the distance between the parallel plates. An improved type of Stark tube using positive rays is described. The kathode is a long, perforated, hollow cylinder, along the axis of which the auxiliary electrode is placed. The canal rays between these two electrodes are subjected to the electric field. This type of tube can be made to yield as great a depth of light as desired, thus giving greater intensity than the ordinary Stark tube, and affording some possibility of obtaining the Stark-effect by absorption for hydrogen and helium. The Stark-effect for the zinc triplet $1s - 1p$ was thoroughly studied under fields from 30,000 to 40,000 volts per cm., and with dispersions ranging from 10 to 4 Å. per mm. The Stark-effect, if any, was found to be negligible. Nagaoka's positive results are apparently due to the pole effect. Preliminary results for the similar $1s - 1p$ triplet of cadmium and the thallium line $1\pi - 1\sigma$ (5350·5 Å.) also show no appreciable Stark-effect. AUTHOR.

1025. *Zeeman-Effect and Multiplet Structure.* **A. Bramley.** (Frank. Inst., J. 201. pp. 3–16, Jan., 1926.)—Practically all the known types of Zeeman pattern satisfy Landé's empirical relation within the errors of observation. In the present paper a somewhat similar formula is derived for the multiplet separations of a line, which shows the intimate connection between these two distinct phenomena. G. W. DE T.

1026. *Mechanical Models for the Zeeman-Effect.* **C. G. Darwin.** (Phil. Mag. 1. pp. 161–195, Jan., 1926.)—After discussion of the field of applicability of such models for spectrum lines, the principles are explained and the actual form is given of a simplification of Voigt's model of the D-lines, which invests it with much greater physical significance. It is shown that some types of multiplets cannot be represented by the simple form of model. An attempt is made to construct a model for the triplet. The result satisfies all the known properties, but no success has been attained in finding a simple form such as would suggest a basis of physical reality. The technical principles of the theory of vibrations are also considered. The paper is mathematical. F. S.

1027. *A New Source of Light and its Practical Possibilities.* **H. Schüler.** (Zeits. f. Physik, 35. 5. pp. 323–337, 1926.)—An experimental arrangement is here described by means of which it is possible to produce glow discharges of pure metal vapours. The light image (lines, bands, continuous spectra) is observed simultaneously under different excitation conditions. The difference between arc and spark lines or between single and triple lines can be determined. Further, the arrangement enables the lighting of molecules, which through collisions of the second kind are excited, to be observed. **Errata** (*ibid.*, 36. 8. p. 639. 1926). A. E. G.

1028. *Broadening of the Mercury Resonance Line by Molecular Collisions.* **W. Orthmann.** (Ann. d. Physik, 78. 7. pp. 601–640, Jan., 1926.)—One factor tending to broaden an emission or absorption line of a vapour is the damping by molecular collisions suggested by Lorentz. The author's experiments go to show that the broadening of the absorption line λ2536·7 of mercury-vapour when, keeping the number of Hg atoms unchanged, the number of molecular collisions is increased, is the same whether this is accomplished by raising the temperature or by increasing the partial pressure of the hydrogen mixed with the Hg vapour. Both these procedures increase the number of molecular collisions by amounts which can be calculated on the kinetic theory. A discussion is given of the effect on the total absorption of a given thickness of vapour, of an alteration in the shape of the absorption line as specified by its half-value width. The experimental procedure consists in using a mercury-vapour lamp to excite the resonance line λ2536·7 in Hg vapour contained in a quartz chamber at a pressure of 0·0013 mm. The resonance radiation emitted obliquely to the incident beam is rendered parallel by a quartz lens, passes through the quartz vessel containing the Hg vapour whose absorption is being measured, and is finally converged on to the sensitive plate of a photoelectric cell. For all the main experiments the density of the absorbing Hg vapour corresponded to the saturated vapour-pressure of mercury at 15·5° C. In the temperature variation experiments the hydrogen present corresponded to a pressure of 253 mm. at room-temperature, and the range of temperature was 50–500° C. In the other series of measurements the temperature remained at 15·5° C. and the pressure of the hydrogen was varied from 0–771 mm. Full details are given of the sources of error and their elimination; in particular the effect of Doppler broadening is considered and shown to be unimportant under the conditions worked with. The conclusion is that the broadening of the line is determined by the number of molecular collisions, and the theory of Holtsmark based on molecular electric fields is rejected. W. S. S.

1029. *On the Extinction of the Hg-Resonance Radiation in Mercury-Vapour under High Pressure.* **W. Orthmann** and **P. Pringsheim.** (Zeits. f. Physik, 35. 8–9. pp. 626–632, 1926.)—In this investigation it is found that with a mixture of mercury and thallium vapours the lines of the sensibilised thallium fluorescence appear at the absorption of the mercury resonance line 2536·7 Å., when the mercury-vapour density is so increased that the mercury resonance itself is no longer observed. It is concluded that the extinction of the mercury resonance is due at least partly to the increase of vapour density effecting a transformation of the excited atoms into the metastable condition. Since some of the thallium lines still possess their full intensity at a mercury-vapour pressure of over 1 atmos., while the thallium pressure itself amounts to only about 0·01 mm., the metastable mercury atoms must survive more than 10^4 impacts with other mercury atoms without giving up their excitation energy. Experimental details are included. H. H. Ho.

1030. *The Region of Action of Excited Atoms.* **W. Schütz.** (Zeits. f. Physik, 35. 4. pp. 260–275, 1925.)—Experimental evidence is brought forward to show that, for resonance radiation of Hg vapour in a magnetic field, at the excitation of the central Zeeman component (π) the outer components (σ) are affected in spite of the time of collision, which is greater than the duration of the Hg atom in the $2p_2$ state. For the experiments carried out, a primary radiation of frequency 2537 was directed by means of a quartz lens through the window of an evacuated vessel placed in the homogeneous part of the field between the poles of a strong electromagnet. The secondary radiation produced was photographed, using a camera with a quartz lens, along a direction perpendicular to the field and to the primary radiation. For experiments on polarised radiation calcspar was used. It was found that the ratio of the intensity of the π component to that of the sum of the σ components was dependent on the density of the Hg vapour, but independent of the magnitude of the Zeeman separation. To trace back the phenomenon to the joint action of neighbouring excited atoms, the introduction of a factor is necessary, which increases the time of collision expected from the kinetic theory of gases (order of magnitude 50–100). This is defined as the sensitivity factor, and its significance is discussed for a series of known experimental facts. R. S. R.

1031. *Analysis of Certain Molecular Spectra.* **D. M. Dennison.** (Phil. Mag. 1. pp. 195–218, Jan., 1926.)—The infra-red spectra of the hydrogen halides, CO_2 and NH_3, are discussed in a similar manner to the recent discussion of CH_4 [see Abstract 307 (1926)]. General principles of molecular vibrations are first considered and applied to diatomic molecules (the halides), symmetrical triatomic molecules and axially symmetrical molecules with four atoms. Qualitative agreement is obtained with experimental results of various observers as regards the relative intensities of the bands. The absolute value of the absorption of fundamental bands is then discussed. F. S.

1032. *The Fine Structure of the Balmer Lines.* **G. Hansen.** (Ann. d. Physik, 78, 6. pp. 558–600, Dec., 1925.)—The first five members of the Balmer series of hydrogen lines, formed of double lines of almost equal intensity very close together, were investigated. The hydrogen was contained in a wide discharge-tube cooled by liquid air and rendered luminous by a direct current. Dispersion was effected by a Lummer-Gehrcke plate, and the photographs of the lines were examined with a micro-registering photometer similar to that used by Koch [see Abstract 1522 (1912)]. The results are discussed in the light of the Sommerfeld-Kramers theory [see Abstract 652 (1921)]. G. E. A.

1033. *Fine Structure of Balmer Lines.* **L. Janicki** and **E. Lau.** (Zeits. f. Physik, 35. 1. pp. 1–6, 1925.)—New values of $\Delta\nu$ for the Balmer series have been obtained from photographs previously taken by Gehrcke and Lau using a Lummer-Gehrcke plate. The final value for $\Delta\nu$ is 0·307 for H_α, 0·305 for H_β, and 0·315 for H_γ. The value is in good agreement with the prediction of Sommerfeld's theory. The Rubinowicz-Bohr-Kramers theory gives larger values, unsupported by experimental results. It is shown, having regard to the correction of Paschen's original measurements by Lau, that the first Sommerfeld selection principle agrees more closely than that of Rubinowicz-Kramers. W. V. M.

1034. *The Continuous Hydrogen Spectrum.* **H. Schüler** and **K. L. Wolf.** (Zeits. f. Physik, 35. 7. pp. 477–489, 1926.)—The continuous hydrogen spectrum is independent of electron-stimulation through shocks of the second kind so soon as the resonance potential of the elements used for stimulation exceeds 2·9 volts (calcium). At the same time there is a dependence of the short-wave end of the continuous spectrum upon the magnitude of the resonance-potential. Earlier experiments (*ibid.*, 33. 1–2. pp. 42–47, 1925) had shown the intensity of the continuous spectrum to depend upon the electric field. From these data the continuous spectrum is regarded as a recombination spectrum of two unstimulated atoms in the electric field. This conception coordinates the experimental data. A relation is determined between the long-wave limits of the continuous absorption-spectrum and the continuous emission spectrum. **K. L. Wolf** (*ibid.*, 35. 7. pp. 490–494, 1926). Also **Errata** (*ibid.*, 36. 8. p. 640, 1926). A. D.

1035. *The Structure of the Negative Oxygen Bands.* **R. Frerichs.** (Zeits. f. Physik, 35. 8–9. pp. 683–688, 1926.)—A source of light is described by the use of which the negative bands of oxygen may be obtained with such intensity as to enable photographs in the second order of a 6·4 m. grating to be obtained in fifteen minutes. Five groups of negative bands were studied in the red, yellow and green of the first-order spectrum. The precise structure of the bands is described and an attempt made to arrange the lines in series. Using the combination principle, a series of terms is calculated, these terms being found in no other band system of oxygen so far as known at present. W. V. M.

1036. *Electro-optical Researches on Sodium Vapour (Anomalous Electrical Double Refraction; Stark-Effect on the Resonance Radiation).* **H. Kopfermann** and **R. Ladenburg.** (Ann. d. Physik, 78. 7. pp. 659–679, Jan., 1926.)—§ 1 of this paper considers the conditions necessary for the proof of electrical double refraction and continues a previous investigation [see Abstract 2973 (1924)] on the effect of a strong electrical field on the absorption lines of sodium-vapour. § 2 gives briefly the experimental arrangements employed. § 3 contains proof and measurement of electrical double refraction at the D_2-line. § 4 deals with absolute measurements, comparison experiments with a longitudinal magnetic field, magneto-rotation, and circular dichroism; while § 5 is devoted to theoretical considerations, including the splitting of the terms. § 6 investigates the electrical effect on the resonance lines of sodium. § 7 summarises the results as follows: (1) A positive electrical double refraction of sodium-vapour near to the D_2-line, but not at the D_1-line, has been established. (2) This effect has nothing to do with the usual cause of electrical double refraction (*e.g.* in the Kerr-effect), *viz.* the orientation of asymmetric atoms in the field but on the electrical displacement of the D_2-line where the π and σ components are differently displaced towards the red, whilst equally for D_1-line. (3) The last difference is about 0·001 Å.U. at 30,000 volts/cm. (4) The electrical levels of the *p*- and *s*-terms belonging to the D-lines have been established. **Errata** (*ibid.*, 79. 1. p. 96, Feb., 1926). H. H. Ho.

1037. *Line Absorption Spectra of the Alkali Metals.* **A. L. M. Sowerby** and **S. Barratt.** (Roy. Soc., Proc. 110. pp. 190–197, Jan. 1, 1926.)—Examination of the line absorption spectra of the alkali metals shows that, contrary to the selection principle, according to which in any interorbital transition occurring in absence of an external field the azimuthal quantum numbers of the original and final orbits must differ by unity, the alkali metals are all able to absorb the combination lines

$1s - md$ in the absence of an electric field. The first two pairs of the cæsium series $1s - md$, now observed for the first time, either in emission or in absorption, have wave-lengths which indicate that the present accepted term values for cæsium are inaccurate. The absorption of $1s - 2d$ for potassium is not affected by the presence of argon at 2 atmos. pressure. When certain assumptions are made, it is estimated that 12,000 times as many atoms are able to absorb the first member of the principal series of potassium and rubidium as can absorb the line $1s - 3d$, the ratio being the same for the two metals. The corresponding lines of different alkali metals may be detected in absorption at equal vapour-pressures, and the atomic "extinction coefficients" must be approximately the same for corresponding lines. T. H. P.

1038. *The Spark Spectrum of Potassium.* **W. Dahmen.** (Zeits. f. Physik, 35. 7. pp. 528–539, 1926.)—An attempt to arrange some of the lines previously observed by the author [Abstract 569 (1925)]. For elements of large atomic number the orbits of electrons deviate from the hydrogen type as shown in the growing quantum defect whose value differs from element to element. For certain orbits the size of the quantum defect (as atomic constant q^* of the spark spectrum) in the series formula $(m_1q^*) = \frac{4R}{(m + q^*)^2}$ is double the value of q in $(mq) = \frac{R}{(m + q)^2}$ for the arc spectrum of the previous element in the periodic system. This relationship is not likely in the principal and II subordinate series, but its accuracy is greater in others and increases with increasing azimuthal quantum number. A further relationship, according to Fues, between the fundamental term $1s$ of the arc spectrum and the $1s$ of the spark spectrum of the same element is that $(1s) = \frac{1}{2}(1s)$ approximately. Using the series arrangement by Nissen for the argon spectra, an attempt is made to calculate term values for the potassium spectrum *à priori*. The s terms agree with the previous Fues rule, but not the p terms. Tables of results are given. q^* is obtained as 0·14528; for q for argon Nisson found the value 0·07332. Tables analogous to those of Sommerfeld and Reinheimmer for Cs and Rb, and including 110 constant difference lines, are given, and gaps may be filled by further ultra-violet investigation. In general $1s$ and $2s$ are larger than $2p_x$, but for larger x, $2p_x$ is larger than $2s$ and $(2p) - (2s)$ consequently negative, but $(2p) - (3s)$ positive. A complete classification is not yet possible, but may arise from further work on the argon spectrum. W. V. M.

1039. *Absorption Spectra of the Vapours of Aluminium, Gallium, Indium and Thallium in the Ultra-violet.* **J. G. Frayne** and **A. W. Smith.** (Phys. Rev. 27. pp. 23–30, Jan., 1926.)—Absorption in heated vapours.—The metals were vaporised in a graphite tube 15 cm. long heated with an oxyacetylene torch to temperatures up to 2000° C. A tungsten under-water condensed spark provided a continuous spectrum. Aluminium.—At about 1200° C. the first 7 pairs of the first subordinate series were absorbed. The relative intensities differ from what might be expected from the Bohr theory standpoint. No absorption was observed for the second subordinate series. Gallium.—At a temperature of about 1500° C. 17 prominent lines appeared, including the first 4 pairs of the first and second subordinate series and the 5th term of the

$2p_1 - ms$ series. Indium.—At a temperature of about 1200° C. 18 lines appeared, including the first 3 pairs of the first subordinate series, the first 5 pairs of the second subordinate series and the 4th term of the $2p_1 - md$ series. Thallium.—At 400° C. 4 lines of the $2p_2 - ms$ and 4 of the $2p_2 - md$ series appeared, widening into bands with increasing temperature. At 800° C. lines from the $2p_1$ level appeared as fine absorption lines. These results verify those of Grotrian. Absorption in the arc.—A bead of the metal was placed in a crater. Aluminium.—In a 15-amp. arc the lines of the $2p_2 - md$ and $2p_1 - md$ ($m = 5$ to 11) were completely absorbed. Indium.—Besides the resonance lines $2p_2 - 2s$ and $2p_2 - 3d$, the lines $2p_1 - 2s$ and $2p_2 - 3d$ were completely absorbed. Relative behaviour of lines from $2p_1$ and $2p_2$ levels.—The lines for the $2p_1$ level for gallium and indium are as readily absorbed as those for the $2p_2$ level, and therefore may also be resonance lines. AUTHORS.

1040. *The Effect of Solvents on the Absorption Spectrum of a Simple Azo Dye.* **W. R. Brode.** (J. Phys. Chem. 30. pp. 56–69, Jan., 1926.)—The absorption limits of some thirty organic solvents have been determined and their region of total absorption has been observed throughout the ultra-violet to a frequency of 1360 for a thickness of 1 cm. A Hilger sector photometer method with quartz spectrograph was used, the arc being between tungsten electrodes under distilled water. A comparison was made of photographs of spectra for the clear solvent and the solution. For benzeneazophenol in these various solvents, and probably also for other simple azo dyes, Kundt's law was found not to hold, and some evidence quite reversed the relation. Further, there appeared to be no definite relation between the refractive indices or the dielectric constants of these solutions and the frequency of the absorption band of the dye dissolved in them. For mixed solvents the dye appears to give the absorption frequency for the most polar solvent, even if this solvent is present in a very low percentage, and there is also a slight dilution effect in such cases. Finally, the height of the band appears to be greater for polar solvents than for non-polar solvents. R. S. R.

1041. *X-Rays in Industry.* **G. W. C. Kaye.** (Nature, 117. pp. 123–126, Jan. 23, 1926.)—A popular form of lecture upon the industrial applications of X-radiation and adding no new facts. B. J. L.

1042. *The Interpretation of Spectra emitted by Solid Nitrogen and Solidified Mixtures of Nitrogen and Inert Gases.* **L. Vegard.** (Comptes Rendus, 182. pp. 211–213, Jan. 18, 1926.)—A continuation of previous work [Abstract 2093 (1924)]. By bombardment with canal rays a diffuse series (A) is produced from nitrogen, while two distinct series (α and β) are obtained from argon containing traces of nitrogen. Rapid kathode-rays give for pure nitrogen two diffuse series (B and B′) and a series of doublets (c, c'). In argon containing small quantities of nitrogen they give rise to series $\gamma, \gamma', \delta, \delta'$ and a system of series ϵ. All the series can be expressed by the Deslandres relationship

$$\nu = Q + R\mu + S\mu^2 \quad (\mu = 0, 1, 2, \ldots)$$

Values of the constants Q, R and S are given. The system ϵ is represented by the equation

$$\epsilon_n^p = 16{,}747 + 1755m + 16n^2 + (480 + 32n)p$$

Each value of $n(0, 1, \ldots 7)$ corresponds to a series in $p(0, 1, \ldots 6)$ where $\Delta\nu$ is constant. The large values of R betray oscillatory series. The energy is evidently expressed by

$$W/h = \Sigma\nu_j + \sum_{i=1}^{i=f} (r_i\mu_i + s_i\mu_i^2) \quad (\mu_i = 0, 1, 2, \ldots),$$

$h\Sigma\nu_j$ being energy due to electronic transitions, $h(r_i\mu_i + s_i\mu_i^2)$ energy of an oscillator, and f the number of degrees of freedom. The series ϵ are formed by transitions between two oscillatory terms having the same value of the constant s. The series ϵ and η, like the N_1, N_2 and N_3 bands, appear in the light which persists and are, consequently, lines characteristic of the crystalline form of nitrogen. W. V. M.

1043. *Theory of the Continuous X-Ray Spectrum.* **M. S. Vallarta.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 1–7, Dec., 1925. Paper read before the Am. Phys. Soc., Nov., 1925.)—An attempt to provide a theory of the continuous X-ray spectrum, based on the following assumptions: (*a*) The continuous spectrum is due solely to the stoppage of electrons in the anti-kathode. (*b*) Assumption of the Bohr frequency relationship. (*c*) Conservation of energy and momentum for the system electron, anti-kathode atom and light quantum. (*d*) When impinging on an anti-kathode atom an electron may or may not lose all its kinetic energy. The loss of energy is supposed random. (*e*) The relativity variation of mass with velocity is assumed for all atoms and electrons. (*f*) The laws of inertia of energy and its consequences hold for the emitted light quantum. (*g*) No change in potential energy of either electrons or atoms due to external or intrinsic fields of force. From these postulates it is calculated that a shift in the sharp limit of the continuous spectrum should be observed in different deflections. Thus in the most favourable cases considered, that of electrons striking a target of lithium under a potential difference of 0·5 kv., the calculated shift is 0·1243 X units (10^{-11} cm.). The shift increases with decreasing voltage and atomic number of the target. W. V. M.

1044. *Total Reflection of X-Rays and Variation of Index of Refraction in the Neighbourhood of an Absorption Discontinuity of the Reflector.* **M. de Broglie** and **J. Thibaud.** (Comptes Rendus, 181. pp. 1034–1035, Dec. 21, 1925.)—A study has been made of the reflection of Kα-radiation emitted from anti-kathodes of tungsten, molybdenum and copper, reflected from "mirrors" of aluminium, glass, copper, silver, gold, platinum, and lead, mounted on an optical bench fitted with very narrow collimating windows and exact goniometers. The reflected rays have been recorded photographically. A determination of the angle of total reflection was obtained, using the relation $\mu = 1 - \delta = 1 - \frac{1}{2}\theta_m^2$ by a simple regular rotation of the mirror from the angle $\theta = 0$. The continuous band due to the displacement of the reflected ray on the photographic plate suddenly ceases when the total reflection stops at $\theta = \theta_m$. The observations show that δ is of the order of 10^{-6}. In the case of Kα-radiation from copper reflected from glass, $\delta = 8 \times 10^{-6}$, but reflected from a mirror of copper $\delta = 35 \times 10^{-6}$ (K discontinuity of copper $\lambda_k = 1 \cdot 3978$ Å.). Thus the optical properties of X-rays are found to be identical with those of ordinary light, and obey the same laws, supporting the "undulatory" theory of X-rays, whilst photoelectric phenomena support the corpuscular or quantum theory. A. B. W.

1045. *Remarks on Röntgen Spectroscopy of the Compton-Effect and the Clark-Duane Pseudo-Lines.* **H. Seemann.** (Zeits. f. Physik, 35. 10. pp. 732–742, 1926.)—The search of Walter, Webster and Kulenkampff for the secondary spectrum of Clark and Duane cannot succeed by reason of intensity considerations. Only by exceeding closeness of the source to the crystal and by a special arrangement can the secondary spectrum be picked out from the general blackening produced by the unreflected fluorescent radiation. Also in the spectroscopy of the Compton rays the relative intensity of the displaced and undisplaced lines depends greatly on the relative distances in the arrangement adopted, since the primary radiation is regularly reflected by the micro-crystals of the scattering substance as in the Debye-Scherrer arrangement, while the Compton rays have their wave centres in the scattering substance. Resonance reflection by the excited crystal lattice cannot in the usual arrangement come in, since its effects are swamped out by the much greater weakening due to reflection by the crystal layers. J. E.

1046. *The Polarisation of X-Rays by Crystal Reflection.* **H. Mark** and **L. Szilard.** (Zeits. f. Physik, 35. 10. pp. 743–748, 1926.)—Use is made of the well-known facts that X-rays reflected by crystals are completely polarised, and that if a crystal is illuminated by X-rays plane-polarised in the plane of incidence no reflection occurs. This enables one to use crystals as polarisers or analysers for X-rays. And at the same time the spectroscopic action of the crystal enables the polarisation of the fluorescent and scattered radiation to be studied separately. By such means it is found that, using iron as a radiator, the fluorescent radiation, unlike the scattered radiation, is for angles of diffraction less than 90° unpolarised. The fraction polarised of the scattered radiation for the heavier elements studied in this way is that which would result from a classical scattering by isotropically distributed electrons. J. E.

1047. *Measurement of the Refraction of X-Rays in a Prism by Means of the Double X-Ray Spectrometer.* **B. Davis** and **C. M. Slack.** (Phys. Rev. 27. pp. 18–22, Jan., 1926.)—In the double spectrometer used X-radiation was reflected from a crystal surface *A* through a slit *S* on to a second crystal surface *B*, and thence to the ionisation chamber. Surfaces *A* and *B* were obtained by splitting a single crystal of calcite. The curve obtained for Mo Kα by rocking *B* is a triangle with base about 8 sec. wide. The effect of interposing a prism of aluminium (angle 166°) between *S* and *B* was to shift the curve 5·62″ on the average giving $1 - \mu = 1 \cdot 68 \times 10^{-6}$. The value calculated from the Lorentz dispersion formula is $1 \cdot 77 \times 10^{-6}$. For Cu K$\alpha$ the shift was 5·53″ for a 116° prism, giving $1 - \mu = 8 \cdot 4 \times 10^{-6}$ as compared with the calculated value $8 \cdot 36 \times 10^{-6}$. The accuracy of this method is thus within 5 %. AUTHORS.

1048. *Determination in Absolute Value of the Wave-lengths of X-Rays by Means of a Reflecting Grating on Glass.* **J. Thibaud.** (Comptes Rendus, 182. pp. 55–57, Jan. 4, 1926.)—The spectroscopy of X-rays is based on diffraction by crystalline media, *e.g* rock-salt, whose spacings have not been determined directly. Since, however, X-rays have a refractive index ($\mu = 1 - \delta$) very nearly equal to unity, their reflection can be observed for very small glancing angles. Again, one may hope to diffract them by means of a grating on glass, although the minimum spacing of the grating seems too large to obtain diffraction of wave-lengths of the order of 1 Å. Experiments are described and a photograph reproduced of the effects sought. The diffracted lines are very sharp, and a value of 1·540 Å. is obtained for the Kα Cu radiation using the known constants of the grating. The value obtained is in good agreement with those obtained using crystalline "gratings," and constitute absolute determinations of the X-ray wave-lengths. W. V. M.

1049. *An X-Ray Spectrometer with which Wave-lengths are read directly on an Ordinary Micrometer Screw.* **W. W. Nicholas.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 45–46, Jan., 1926.)—A preliminary account of an X-ray spectrometer. W. V. M.

1050. *Soft X-Ray Absorption Limits of Certain Elements.* **U. Andrewes, A. C. Davies** and **F. Horton.** (Roy. Soc., Proc. 110. pp. 64–90, Jan. 1, 1926.)—Investigations of the voltages corresponding to the critical values of the electron energy associated with some of the longer wave-length absorption stages of seven elements gave the following values in volts :—

Chromium ..	—	60	70	—	143	160	173
Manganese ..	—	68	83	100	152	174	184
Iron	47	73	90	106	166	181	—
Cobalt	—	—	94	113	171	191	—
Nickel	—	—	104	—	178	196	—
Copper	—	—	112	—	193	206	—
Zinc	—	—	119	—	200	214	—

Evidence from comparisons of measured absorption limits and emission lines is deduced to support the view that the generally accepted value of an absorption limit obtained by spectroscopic methods corresponds to the transportation of an electron from the sub-group to the levels of the most loosely bound electrons. Extrapolation of the Moseley curves for the various absorption limits down to low atomic numbers shows that the values obtained in this investigation must be associated with absorption of energy by electrons in the M sub-groups. The several values obtained for each element are attributed to selective absorption stages, resulting in the transference of electrons from the sub-groups associated with the levels M_{I} and $M_{II,\ III}$, to various virtual orbits outside the normally occupied region of the atom, and not to actual ionisation of the atom. The original paper should be consulted for details of the carefully planned experiments and for a very full discussion of the results. W. H. Ge.

1051. *Resonance Absorption in the X-Ray Region.* **V. Posejpal.** (Comptes Rendus, 182. pp. 272–274, Jan. 25, 1926.)—The absorption of the K-radiation of tungsten in tungsten foil is studied with a Seemann spectrograph. It is found that within the limits of experimental error the absorption of the β-radiation is normal, but for the α_2 and α_1 radiation values five or six times greater than the theoretical ones are obtained showing a strong selective absorption as well as the ionisation of the atom. The results would be consistent with the supposition of Stoner that there are four electrons in the L_3 level and two in the L_2. W. H. Gr.

1052. *Magnitude of the K-Absorption Discontinuity. Mass Absorption Coefficients for Wave-lengths on Both Sides of the K Limit.* **F. K. Richtmyer.** (Phys. Rev. 27. pp. 1–17, Jan., 1926.)—(1) Experimental results for six metals.—Using a water-cooled Mo tube, absorption measurements were made for a sufficient range of wave-lengths in each case to determine the constants in the equations for the mass absorption coefficients above and below the K-absorption discontinuity: $\mu_K/\rho = K_K\lambda^3 + \sigma/\rho$; $\mu_L/\rho = K_K\lambda^3 + \sigma/\rho$, in which σ/ρ is the scattering coefficient with a value of 1 or less; λ is in Ångström units; τ_a is the atomic absorption coefficient at the K limit corrected for scattering.

	Mo(42).	Ag(47).	Sn(50).	W(74).	Au(79).	Pb(82).
k_K =	375	545	595	1870	2230	2570
k_L =	50	70	90	330	395	476
k_K/k_L =	7·5	7·8	6·6	5·65	5·65	5·40
$\tau_a(10^{-21})$ =	13·3	11·0	8·90	3·19	2·57	2·37

(2) Comparison with theories.—($k_K/k_L - 1$) is the ratio of the number of photoelectrons originating in the K and L levels for X-rays just shorter than the K limit. It is shown that the theories of Thomson, of Compton and of de Broglie lead to the same values of k_K/k_L, which increase with decreasing atomic number in agreement with experiment except that they are about twice too large. Kramers' formula gives a value which does not vary with N and which agrees well with the experimental values for Mo to Pb, but it applies only to a single electron around the nucleus. A formula modified by use of Bohr's theory of energy levels to remove this restriction gives values nearly three times too large. No present theory, then, is supported by these experimental results. Author.

1053. *K Critical Potential of Neon.* **F. Holweck.** (Comptes Rendus, 182. pp. 53–54, Jan. 4, 1926.)—Continues the work of previous papers [see Abstracts 1109 and 1664 (1925)]. The graph of ionisation current against exciting potential of the X-rays shows a very clear discontinuity, the mean of six measurements giving the critical potential at 862 ± 3 volts. W. H. Gr.

RADIO-ACTIVITY.

1054. *Reflection of α-Particles from Atomic Nuclei.* **H. Pettersson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 15. pp. 1–16, 1925. In English.)—A new method is described for studying atomic disintegration produced by α-particle bombardment. Only particles emitted at large angles relative to the incident α-particles are considered. By means of this "retrograde" method the α-particles scattered nearly backwards from five different elements (*viz.* carbon—as diamond and graphite—magnesium, aluminium, nickel and copper) have been counted. With three of these, known to be disintegrable, no reflected H-particles present were observed at ranges considerably lower than those predicted by the theory of elastic collisions. With two heavier elements, not previously found disintegrable, such particles were observed, but were found to have a range distinctly less than that corresponding to elastic impacts. Evidence of H-particles from disintegrated atoms of copper and, less definitely, of nickel were found. Possible explanations are suggested for the lack of reflected α-particles, based on the assumption that the α-particle may penetrate within the nucleus it hits. [See also Abstracts 918 (1922) and 1834 (1924).] A. B. W.

1055. *Absorption of β-Rays by Matter.* **(Mrs.) J. S. Lattès** and **G. Fournier.** (Comptes Rendus, 181. pp. 1135–1136, Dec. 28, 1925.)—In a previous communication the authors have shown that the absorption of secondary β-rays is expressed by the linear law $\mu/\rho = a + b\mathrm{N}$ [see Abstracts 1126 (1925) and 779 (1926)]. This law is now shown to hold for other β-rays emitted from Ra in equilibrium with its disintegration products, the different β-ray groups giving different values of the constants "*a*" and "*b*." The law has great generality for very slow and very fast β-rays. A. B. W.

1056. *Structure of Nucleus of Radio-active Atoms and the Emission of γ-Ray Spectra.* **J. Thibaud.** (Comptes Rendus, 181. pp. 857–859, Nov. 30, 1925.)—In order to explain the failure of Coulomb's law of force near the nucleus of an atom, the author assumes as a basis that the nucleus of a radio-active atom is constructed of the following: (*a*) A central portion very dense, of total charge + N*e*, producing in its viscosity a force of the form $\mathrm{F} = \frac{\mathrm{N}e^2}{r^2}\left(1 - \frac{b^{a-2}}{r^{a-2}}\right)$, *r* being the distance from the centre of the nucleus; (*b*) certain positive elements gravitating towards the nucleus and lying in the field of force referred to in (*a*). On the basis of these assumptions the author deduces certain relations of the γ-ray spectra of radio-active atoms. A. B. W.

1057. *The Atomic Number of a Radio-active Element at the Moment of Emission of the γ-Rays.* **C. D. Ellis** and **W. A. Wooster.** (Cambridge Phil. Soc., Proc. 22. pp. 844–848, Nov., 1925.)—In order to be able to photograph the excited β-ray spectrum of platinum and the natural spectrum due to radium B and C, simultaneously on the same plate, a thin-walled glass tube with external diameter 0·4 mm. was filled with radon, and introduced into a platinum tube 0·97 mm. in external diameter with walls 0·25 mm. thick. The outside of the platinum tube was coated with a weak layer of radium B and C, which gave the natural β-radiation of these substances, while the γ-rays from the radium B and C formed inside the glass tube penetrated the platinum, and gave rise to the photoelectrons constituting the excited spectrum. The edge of the excited line was due to an extremely thin layer on the surface of the platinum, and it was calculated that the distance between the natural and the excited lines would be about 3 mm. in the apparatus used if the γ-ray were emitted before disintegration, and 4 mm. if afterwards. The results for the three main γ-rays of radium B and the strongest of radium C are given in a table, and show very clearly that the γ-ray is emitted after the disintegration. It is pointed out that using this method each γ-ray is investigated in turn, while Rutherford and Wooster, and also Black, had to deal with the γ-rays collectively. H. N. A.

HEAT.

1058. *The Periodic Flow of Heat and the Thermal Stress in the Wall of a Long Hollow Cylinder.* **M. Maekawa.** (Tôhoku Univ., Technol. Reports, 5. 4. pp. 1–24, 1925.)—The temperature distribution and the stresses induced by this distribution in the wall of a long hollow cylinder are here treated mathematically. The inside and outside of the cylinder are supposed to be occupied by fluids of different temperatures, and the temperature of the inner fluid varies periodically while that of the outer remains constant (or *vice versa*). Commencing with the Fourier conduction equation $\partial\theta/\partial t = a^2[\partial^2\theta/\partial r^2 + \partial\theta/r\,.\,\partial r]$, where $a^2 = \lambda/cp$, and making the solution fit the boundary conditions at $r = r_1$ and $r = r_2$, the calculation is made with the aid of Ber and Bei functions. The phenomena of such a periodic flow of heat often occur in engineering problems, *e.g.* the wall of the cylinder in a heat engine. The simplest case, that of a simple harmonic variation in the inner fluid while the temperature of the outer remains constant, is first considered. The formulæ obtained are found to be considerably simplified when two approximations are made: (1) The introduction of the asymptotic expansions of the Ber and Bei functions; (2) the neglect of a term $e^{-\sqrt{2}\,.\,c\,.\,s}$, where c is the specific heat and s the wall thickness. The equations obtained show a temperature wave in the wall of rapidly decreasing amplitude, the greatest amplitude occurring at the inner surface. The wave-length is also greatest at the inner surface, but while the amplitude decreases almost to zero at the outer surface the wave-length only slightly decreases. As regards the stress distribution, stress waves are set up having a rapidly decreasing amplitude. It is shown that the most dangerous point is at the inner surface. Next the general case is treated, and finally a numerical example is taken of a cylinder of mild steel where its inner and outer radii are 5 and 6 cm., the inner fluid a gas whose temperature undergoes a simple harmonic vibration from 20° to 1500° C. with a period of 1 sec., and the outer fluid is water at 80° C. Temperature and stress distributions are given in diagrams. The maximum temperature at the inner surface is shown to occur about $\frac{1}{8}$ sec. later than the maximum temperature of the gas. The maximum compressive stress at the inner surface is 540 kg./cm.^{2}, and the maximum tensile stress at the outer surface 378 kg./cm.^{2}. T. B.

1059. *Measurement of Thermal Conductivities of Gases.* **H. Gregory and C. T. Archer.** (Roy. Soc., Proc. 110. pp. 91–122, Jan. 1, 1926.)—Deals with the very accurate measurement of thermal conductivities of air and hydrogen. The gas under investigation is confined in two similar cylindrical glass tubes of unequal length and is heated by an electrical current passing through coaxial platinum wires maintained at constant temperature by a bridge. Careful consideration is given to (1) the methods and results of previous workers, (2) elimination of convection errors, (3) radiation from the heated platinum wires, (4) correction for the effect of the glass walls, (5) accurate measurement of the factors involved and the final accuracy of the determined conductivities, and (6) the variation of conductivity with temperature. W. H. Ge.

1060. *Thermal Properties of Viscous Sulphur.* **P. M. Monval.** (Comptes Rendus, 182. pp. 58–60, Jan. 4, 1926.)—A short account of a determination of the latent heats of transformation and the specific heats of various modifications of sulphur. The chief results are detailed below: (1) The transformation from liquid to viscous sulphur at 160° takes place with an absorption of heat of 2·8 cal./gm.; (2) the specific heat of orthorhombic sulphur is 0·176, of liquid sulphur 0·220 and viscous sulphur 0·290; (3) the transformation from orthorhombic to monoclinic sulphur at 95° C. has a latent heat of 2·7 cal./gm., while the heat of fusion of monoclinic sulphur is 9·3 cal./gm. W. V. M.

1061. *Laws for the Molecular Heat of Non-associated Fluids and their Vapours.* **W. A. Holzschmidt.** (Zeits. f. Physik, 35. 4. pp. 313–315, 1925.)—The author traces the connection between the two empirical relationships announced by Tyrer [Abstract 1279 (1915)] and by Konowalow on the basis of the law of corresponding states as expressed in van der Waals' equation. E. G.

1062. *Measurement of the Vapour-Pressure of Carbon.* **F. Born.** (Zeits. techn. Physik, 7. 1. pp. 24–31, 1926.)—This paper compares and critically discusses the results which have been obtained by various investigators of the vapour-pressure of carbon. At the end of the paper there is an appendix containing the literature of the subject. The measurement of thermal evaporation can be made by two methods: (1) Measurement of vapour-pressure; (2) measurement of velocity of evaporation. The first method depends on the fact that the temperature of the positive crater of the carbon arc depends on the pressure of the surrounding gas, and is independent of the current strength, of the arc length, and of the chemical properties of the gas. Lummer used this method and employed the relation $\frac{H_1}{H_2} = \left(\frac{T_1}{T_2}\right)^x$, where H denotes the brightness of the crater and T the temperature. Fajans, employing Lummer's results, obtained the relation $\log p = \frac{a}{T} + b$, where p is the vapour-pressure, and considered that Lummer's "temperature-curves" were vapour-pressure curves. Guckel and Kohn repeated these experiments with great care. The results of these and other authors are plotted in curves and critically discussed. The second method for the determination of vapour-pressure depends on the measurement of the loss of weight of a carbon filament or rod in a vacuum, and is based on Langmuir's formula $m = p\sqrt{\frac{M}{2\pi RT}}$ grammes per cm.^{2} per sec., which was obtained for mercury at room-temperature. The formula also assumes that the coefficient of accommodation is unity, and it seems questionable whether this is true for a substance with high boiling-point like carbon. The life of a carbon filament is deduced from the results of observation and compared with that actually found. Large discrepancies are seen to exist. Finally the author comes to the following conclusions: Either (1) the carbon arc gives vapour-pressure curves, and to make these agree with evaporation experiments the coefficient of accommodation at 4000° must be unity and must greatly decrease at lower temperatures with decreasing vapour-pressure, or (2) if the coefficient of accommodation is unity at all temperatures, the values obtained from the velocity of evaporation are vapour-pressures, but then those obtained from the arc cannot be vapour-pressures. To determine which is the correct conclusion a redetermination by both methods is necessary, using very pure graphite, such as obtained by the Pirani-Fehse method. T. B.

1063. *The Heat Capacities of Some Metallic Oxides.* **G. S. Parks** and **K. K. Kelley.** (J. Phys. Chem. 30. pp. 47–55, Jan., 1926.)—An electrical method was employed to determine the specific heat of MgO, CaO, Al_2O_3, hematite and magnetite over a range of temperature from 87° Å. to 291° Å. An accuracy mainly of 0·5 % was reached, while impurities would not introduce an error exceeding 1 %. From these results the corresponding atomic heats were calculated. For Al_2O_3 in the sapphire form a low atomic heat was found, confirming the view that low atomic heat is a concomitant of exceptional hardness. Noteworthy heat absorption occurred for hematite at 113–117° Å., which is probably due to a change in magnetic properties, for the crystal form appears unaltered. Values of the entropy of these oxides at 25° C. and also of the free energies have been calculated. R. S. R.

1064. *Temperature Measurements on Incandescent Iron.* **M. Moeller, H. Miething** and **H. Schmick.** (Zeits. techn. Physik, 6. 12. pp. 644–651, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Temperature correction values are given for measurements with the glowing filament pyrometer and with the ardometer (total radiation pyrometer) of the surface radiation of incandescent pure and oxydised iron. In the case of the glowing filament pyrometer the black temperature was measured on the surface of an electrically heated small iron tube and the true temperature at an opening in the wall of the tube, the correction being calculated from both. The measurements with the ardometer were made on incandescent iron sheets, followed by corrected readings with the optical pyrometer. Numerous curves and tables are given. [See Abstract 2719 (1925).] E. F.

1065. *Ebullition Device for Low-Temperature and Vacuum Distillation.* **A. F. O. Germann** and **D. M. Birosel.** (J. Phys. Chem. 29. pp. 1528–1532, Dec., 1925.)—A device is described which is useful in vacuum and low-temperature distillations to prevent "bumping" without the use of a foreign gas. T. H. P.

1066. *The Thermal Properties of High-pressure Steam.* **O. Knoblauch.** (Zeits. techn. Physik, 6. 12. pp. 638–644, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—A general survey of the subject, the author's main object being to show that the numerical evaluation of the thermal values of steam necessitates many theoretical considerations side by side with experimental research. It is pointed out that the preparation of the tables and diagrams which aid the practical engineer in his calculations has been achieved only by the close cooperation of thermodynamics with pure and applied physics. E. F.

1067. *Freezing-Points.* **H. W. Foote** and **G. Leopold.** (Am. J. Sci. 11. pp. 42–46, Jan., 1926.)—In the determination of freezing-points the presence in the substance of dissolved air constitutes a source of appreciable error, the measurements being usually made in air at atmospheric pressure under conditions which promote saturation. Thus the difference in freezing-point between air-free and air-saturated benzene at the constant pressure of 1 atmos. amounts to 0·031°. It is suggested that the freezing-point be defined as the temperature at which solid and liquid are in equilibrium when saturated with dry air at a pressure of 1 atmos. In this case the triple point of water lies at + 0·0098°, whereas, if pressure alone is considered without the effect of dissolved air, the triple point is + 0·0075°. The effect of dissolved air on the melting-point is usually much greater with organic compounds than with water. **T. H. P.**

1068. *Thermal Properties of Ice and Water-Vapour.* **J. E. Fjeldstad.** (Geofysiske Publ. 3. 11. [15 pp.], 1925.)—The sublimation-heat of ice at temperatures below 0° C. appears to have remained unknown. The author finds it to be approximately constant. **A. D.**

1069. *The Joule-Thomson Effect in Air.* **J. R. Roebuck.** (Nat. Acad. Sci., Proc. 12. pp. 55–58, Jan. 1926. Am. Acad., Proc. 60. pp. 537–596, Dec., 1925.)—Air compressed to a chosen pressure, lying between 30 and 220 atmos., is passed through a temperature-equalising coil of pipe in an oil bath held at one of a series of temperatures between 25° and 300° C. around a resistance thermometer bulb, through the wall of a round-ended tube of porous porcelain, around a second thermometer inside the porcelain tube, through a control valve where it drops to atmospheric pressure, and finally back to the compressor. The oil-bath temperature is kept constant by means of electrical heating controlled by an electrical thermostat. The inlet pressure is kept accurately constant by a rotating piston barostat, which controls a spill valve through which a small fraction of the compressed air can be wasted. The temperature of the inlet thermometer and the difference of temperature between the two thermometers is read on a Callendar-Griffiths bridge. The performance of this form of porous plug is studied in detail, particularly as depending on the external and internal arrangements. Theory demands that the difference of temperature across the wall should depend only on the temperature and pressure conditions, and not at all on the rate of flow or particular plug. All the results given satisfy these conditions, except at the low-pressure (large volume) state where kinetic energy effects are very difficult to control. Tables give the Joule-Thomson coefficient as functions of temperature and pressure and various deduced results. The temperature of the ice-point on the thermodynamic scale is found to be 273·15°. **G. A. S.**

1070. *Aberrations from the Ideal Gas Laws in Systems of One and Two Components.* **O. Maass and J. H. Mennie.** (Roy. Soc., Proc. 110. pp. 198–232, Jan. 1, 1926.)—The results are given of measurements, to within 0·05 %, of the density of carbon dioxide at pressures up to 1 atmos. and at temperatures lying between − 70° and + 200° [see Abstract 899 (1925)]. It is shown that van der Waals' equation may be derived by considering the effect of the volume occupied by the molecules, not on the total gas volume, but on the pressure registered by a manometer. The resulting quadratic equation is valid over the range for which the mean free path equation holds, and the "b" of the van der Waals' equation is found to be a function of the temperature and to be related to the mean free path. The actual value of b determined from the experimental values for carbon dioxide varies with the temperature in the manner indicated, and when constants derived from viscosity data are introduced, the equation reproduces satisfactorily the experimental results. Measurements of the density of water-vapour at pressures up to 1 atmos. and over the temperature range 98° to 200° give results which are accurate to at least 0·1 % and which show greater divergence from the ideal density than can be accounted for on the basis of the equation of state. It is assumed that polymerisation takes place, the molecular condition of water-vapour being represented by the equilibrium, $2H_2O \rightleftarrows (H_2O)_2$. A distinction is drawn between association and the equation of state effect, but it is not possible to calculate, from the results quoted, the separate influences of these two effects in producing the deviation from ideal density. At about 100° and 1 atmos. pressure the degree of association is approximately, and probably rather less than, 1 %. The highly polar character attributed to water appears to be a property of the dihydrol molecule, monohydrol being relatively non-polar. Measurements of the deviations from Dalton's law at 1 atmos. and at temperatures between 98° and 200° of approximately equimolecular mixtures of water-vapour with carbon dioxide and with ammonia give results in accord with the above conclusions regarding the molecular constitution of water-vapour and show that the mutual attractions of the components in these systems are comparatively small.

T. H. P.

1071. *Mass-Action Equation for Compressed Gases, with Application to the Haber Equilibrium Data.* **L. J. Gillespie.** (Am. Chem. Soc., J. 48. pp. 28–33, Jan., 1926.)—From the equation recently given [Abstract 1693 (1925)] for the fugacity of a gas in a mixture, a general mass-action expression is derived for compressed gases at constant temperature, and assumption that the partial molal volumes may be replaced by the molal volumes leads to a simpler equation, which is also derivable from the Lewis and Randall fugacity rule. The expression is capable of still further simplification to

$$\log K_p = \log K_f + (\Sigma v_1 A_1)p/2 \cdot 3R^2T^2 - (\Sigma v_1 \beta_1)p/2 \cdot 3RT,$$

where K_f is the value of K_p for $p = 0$ and A and β are constants in the Keyes equation of state. If the existing $p : v : t$ data are extrapolated by means of the Keyes equation of state, the above expressions are in accord with the Haber equilibrium data obtained by the Fixed Nitrogen Research Laboratory up to a pressure of 100 atmos. These results furnish an excellent verification of the fugacity rule proposed by Lewis and Randall, and also lead thermodynamically to the expectation that for the Haber equilibrium K_p will not vary greatly with composition at constant temperature and pressure up to about 100 atmos.

T. H. P.

1072. *Heat Capacity and Entropy of Lead Bromide and Bromine.* **W. M. Latimer and H. D. Hoenshel.** (Am. Chem. Soc., J. 48. pp. 19–28, Jan., 1926.)—The results are given of measurements of the specific heats of bromine and lead bromide at temperatures lying between 14° K. and room-temperature, by means of a specially designed vacuum calorimeter, the temperatures being determined by lead wire resistance thermometers. The values obtained give for the entropy of bromine $S_{298} = 18 \cdot 4 \pm 0 \cdot 2$ cal. per degree, and for that of lead bromide, $S_{298} = 13 \cdot 25 \pm 0 \cdot 15$ cal. per degree per average gramme-atom. This value for lead bromide, together with thermal data for the formation of the salt from its elements gives the value $18 \cdot 6 \pm 1 \cdot 0$ cal. per degree for the entropy of bromine. T. H. P.

1073. *The Absolute Value of Entropy.* **M. Saha and R. Sur.** (Phil. Mag. 1. pp. 279–288, Jan., 1926.)—The work of Planck, Sackur, Tetrode, and Ehrenfest relating to the calculation of Boltzmann's expression for the entropy of a thermodynamical system is briefly reviewed and an expression deduced for the entropy of a gas consisting of diatomic molecules. Each molecule is considered as having five degrees of freedom only, three being translational and two rotational. Boltzmann's expression for entropy then takes the form $S = Nk \log \{e^{\frac{7}{2}} . 4\pi V . m^{\frac{3}{2}} . a^{\frac{1}{2}} . b^{\frac{1}{2}} . (2\pi kT)^{\frac{5}{2}} / Nh^5\}$, where N is the total number of molecules, k is Boltzmann's gas-constant, V is the volume, m is the molecular mass, a and b are moments of inertia, and h is Planck's constant. J. S. G. T.

1074. *Heat Radiation of Small Metal Spheres.* **A. Rubinowicz.** (Zeits. f. Physik, 35. 7. pp. 540–547, 1926.)—For macroscope bodies the radiation laws assume that the wave-length of the wave considered is small compared to the linear dimensions of the body and hence diffraction effects are neglected. For small bodies (colloidal particles of $c10^{-5}$ cm.) this no longer holds in the region of heat radiation. Assuming metal spheres at not too high a temperature, an expression is obtained for the total heat radiation (U). Thus $U = 3 \cdot 78 \times 10^{-4} a^3 w_0 T^7$ ergs/sec., where a is the radius of the spheres, w_0 the electrical resistance in ohms corresponding to the specific conductivity, and T the absolute temperature. The paper is mathematical throughout. W. V. M.

1075. *Passage of Heat from a Current of Air to Tubes.* **H. Reiher.** (Zeits. Vereines deutsch. Ing. 70. pp. 47–52, Jan. 9, 1926.)—This is a condensed report of "Summary of Research Work in the Engineering Faculty" appearing in Part 269 of the Summary. The passage of heat from a current of hot air to tubes placed at right angles to the air current and containing a flow of water was measured. The author shows how by making use of the so-called law of similarity, the results may be extended to tubes of other diameters, to other air velocities and to other temperatures, with sufficient accuracy. This method of extending the results of observation is justified by measurements on a feed-water heater. The measurements were made on tubes from $0 \cdot 46$ to $2 \cdot 8$ cm. external diameter with air currents from 2 to $13 \cdot 4$ metres per sec. and temperatures up to 300° C. The paper gives the mathematical equations, the methods of making the observations and a comparison of results with the deductions from theory. Numerous diagrams and curves are included. The paper is not suitable for a brief abstract. T. B.

SOUND.

1076. ***Measurement of Small Movements by Means of Valve Circuits.*** **J. Obata and Y. Yoshida.** (Aeronaut. Research Inst., Tôkyô Imp. Univ. No. 11. pp. 305–319, Aug., 1925. In English.)—This paper gives the results of a series of experiments which were carried out with a view to utilising a triode generating circuit for the precise recording of sounds, pressure variations, and vibrations. A tuned grid circuit was employed, and instead of balancing the anode current by a potentiometer method a transformer was used to connect up the recording instrument, either an Einthoven string galvanometer or a high-frequency oscillograph being used. To record sounds a condenser microphone was employed as the capacity in the generating circuit. Records of the sounds of an explosion, vowels, and whistle were obtained. Finally, as the result of experience obtained, a special instrument called an ultramicrometer has been constructed, which may be conveniently used for problems requiring the measurement of a very small displacement or motion. F. S. B.

1077. *Sound Propagation in the Atmosphere.* **J. Kölzer.** (Meterolog. Zeits. 42. pp. 427–463, Dec., 1925.)—Recent observations have brought to light nothing of significance which would lend greater probability to the hypothesis of v. d. Borne. Also the supposed existence (Weichert and Wegener) of a second zone of audibility arising from the reflection of sound-waves at the surface of the earth speaks rather for the theory of Emden. The existing meteorological data in observations of audibility hitherto have always been too incomplete to make possible a numerical test of the results. In future observations of explosions the chief emphasis must therefore be laid on this point. G. A. S.

1078. *Edge-Tones (I).* **W. E. Benton.** (Phys. Soc., Proc. 38. pp. 109–125; Disc., 125–126, Feb., 1926.)—The eddies which give rise to edge-tones conform to a simple Kármán vortex-system. By assuming (1) that the distance a from the edge to the slit is always equal to l, the distance between two eddies in the same row, and (2) that tone is destroyed when the edge, moved across the jet, crosses the line of eddy centres, the separation (h) of the eddy-rows is measured. At low pressures and with wide slits h/l for air $= 0\cdot276$ (the Kármán theory for the ideal case gives $0\cdot283$). If the edge is moved towards the slit, h decreases proportionally. The experiments show that when the eddies are formed very close to the edges of the slit, and therefore in a field of high velocity-gradient at right angles to the direction of motion, they are deflected towards the middle or principal flame of the jet by an amount which increases very rapidly as a approaches a_0, at which distance tone can only be obtained when the edge lies in the principal plane. With wide slits when $a = a_0$, then $l = a_0$ and $h = 0\cdot67$ times the width of the slit. The theory is given, and measurements of the frequency of the tone and deductions therefrom are promised later.

Discussion.—The bearing of the work on the theory of the organ-pipe was mentioned and the unsatisfactory nature of the organ-pipe as a standard source of sound was pointed out by **W. S. Tucker** and **G. W. C. Kaye.** W. H. Ge.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1079. *On the Possibility of deriving the Characteristic Properties of the Nucleus and Electron from the Metric-Electromagnetic Field.* **H. Reissner.** (Phys. Zeits. 26. pp. 925–931; Disc., 931–932, Dec. 31, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.) Mainly mathematical. By retaining the Maxwell equations and the Einstein equations of the general theory of relativity, an energy tensor may be established for the whole field for any non-static and non-symmetrical state. The introduction of this tensor gives for the uncharged electromagnetic-optic-metric field no measurable difference from the Maxwell-Einstein field. A continuous solution on the basis of this energy tensor is not obtained, but the idea of the point charge, which throughout the metric field with finite size is constant, leads to a system of three equations for the mass and charge of the point charges. These three equations lead to a unique value for the square of the charge, and to a unique mass for each of a pair of adjacent charges. In the *Discussion* which followed, **Sommerfeld** doubted if the author had got more out of the equations than he had put in through the introduction of variable parameters. J. E.

1080. *Relation between the Wiedemann and Joule Effects.* **E. Fromy.** (Comptes Rendus, 181. pp. 1128–1130, Dec. 28, 1925. J. de Physique et le Radium, 7. pp. 13–24, Jan., 1926.)—The Joule-effect is twofold; the longitudinal resulting in a change of length $\Delta l = \rho l$, and the transverse, similarly expressed by $\Delta l = \rho' l$, where ρ and ρ' are functions of the applied field H. In the Wiedemann-effect, the current I sets up a circular field C which combines with the longitudinal field H to give a resultant spiral field. In a tube of mean radius r, the unital torsion θ is given by $\theta = 2(\rho - \rho')\mathrm{HC}/r(\mathrm{H}^2 + \mathrm{C}^2)$. The fields enter symmetrically into the expression, and if one of them becomes zero, there is no torsion and a simple Joule-effect follows. Usually C is small compared with H, and C^2 becomes negligible. The torsion θ may then be expressed as $4\mathrm{I}(\rho - \rho')/r^2\mathrm{H}$, from which it follows that in a constant field the torsion is proportional to the current. Further, with constant current there is a maximum depending on the mode of variation of $(\rho - \rho')/\mathrm{H}$, and there is a point of inversion where $\rho = \rho'$. The sign of the torsion changes with that of $(\rho - \rho')$. G. E. A.

1081. *Derivation of Ampere's Law from Maxwell's Tensions.* **G. Siemens.** (Zeits. f. Physik, 35. 4. pp. 293–298, 1925.)—In the expression of Ampere's law is indicated the relation which specifies the accelerating force between a magnetic field and a stream-line. The case of a cylindrical conductor is considered through which flows a constant current i, producing a magnetic field H_2 inside the space occupied by the conductor and H_1 outside. It is shown that the total accelerating force in the conductor acts in a direction normal to the field H_1 and is composed of a pressure and a tension over the outer surface of the conductor giving per unit length of the conductor a value $\mu_{\mathrm{H}}\mathrm{H}_1 i$, where μ_{H} is the permeability.

This can be extended to conductors of other sections if they are considered to be built of smaller elementary cylinders. [See Abstract 3022 (1924).]
R. S. R.

1082. *Bateman's extended Electrodynamics, and the Mass and Radiation Reaction of an Electron.* **M. Salkover.** (Phys. Rev. 27. pp. 87–92. Jan., 1926.)—From Bateman's earlier stress-energy tensor there are deduced by analogy with the momentum and energy equations based on the classical electromagnetic stress-energy tensor an extra-classical body-force and a condition that may be understood to state the conservation of charge in combination with the Lorentz transformation. It is then shown how this procedure may be reversed so as to derive, from the new body-force and the condition just mentioned, Bateman's tensor with all its components physically interpreted. Next, the mass and radiation reaction of an electron in non-uniformly accelerated, non-periodic motion are calculated from the force (classical and extra-classical) exerted on it by its own field, on the assumptions that the electron is spherical in a rest-system and has a centrally symmetrical distribution of charge. Both come out zero. The result for the radiation reaction is new. Finally the same result for the mass is obtained from the total momentum of the field of an electron in uniform, or quasi-stationary, motion. The present method differs from one recently published by Bateman in not using the restricted relativity transformation for tensors, and in requiring of the distribution of charge only that it be centrally symmetrical. AUTHOR.

1083. *The Mechanism of the Electrification of Small Particles in Clouds.* **P. Arendt** and **H. Kallmann.** (Zeits. f. Physik, 35. 6. pp. 421–441, 1926.)—The mechanism of the electrification of small particles in clouds, fogs, mists, etc., is shown experimentally to be a process of diffusion. [See also Abstract 2356 (1923).] J. S. G. T.

1084. *Measurement of Electrostriction for Carbon Tetrachloride.* **Pauthenier.** (Comptes Rendus, 182. pp. 121–123, Jan. 11, 1926.)—A tube of carbon tetrachloride is placed between the mirrors of a Jamin interferometer. It is further so arranged that one of the optical paths passes between the plates of a condenser whilst the other is outside the field of this condenser. The source of illumination is a carbon arc. The fringes are focussed on to a moving photographic plate by means of a suitably placed cylindrical lens. The condenser is charged and then discharged and the consequent shift of the fringes as shown on the photographic plate is measured. The results obtained are in very close agreement with the values predicted by theory. F. S. B.

1085. *Atmospheric Potential in Lower Stratum of Atmosphere.* **D. Nukiyama** and **K. Nakata.** (Phys. Math. Soc. Japan, Proc. 8. pp. 5–14, Jan., 1926.)—For these measurements a kite baloon was raised to the desired heights and the potential obtained by means of a Kelvin static voltmeter whose case was connected to earth. It was found that the change of the potential with time was irregular, but mean values were obtained of the voltage for different heights of the balloon. The charge collected on the wire was always positive, but the values appear too small even though the possible effects of a sea breeze are taken into account. The probable causes of these low values are examined. It is concluded that (1) the number of positive and negative ions in the lower layers is very great and nearly constant; (2) the amplitude of variation of the potential with time varies with the height, maxima being found at 100, 300 and 500 metres. It is considered that if aircraft let down antennæ, they will collect negative charges to considerable amounts. If the charge is not collected sufficiently rapidly, high voltages will be reached by the aircraft. R. S. R.

DISCHARGE AND OSCILLATIONS.

1086. *Gas-freed Electrodes in Vacuum.* **A. Janitzky.** (Zeits. f. Physik, 35. 1. pp. 27–33, 1925.)—The phenomena described by the author [Abstract 744 (1923)] are not to be explained, as Güntherschulze suggests [see Abstract 1706 (1925)], by deposits on the walls of the bulb; and in ion tubes they can only be referred to the gas-freed condition of the electrodes. A. D.

1087. *Cooling Effect in Oxide Kathodes.* **G. Michel** and **H. J. Spanner.** (Zeits. f. Physik, 35. 6. pp. 395–400, 1926.)—The cooling of glowing oxide kathodes is here measured by observing the decreasing electron current, and from these results the emerging work $\delta\phi$ of the electrons is calculated. For CaO, SrO, BaO the values of $\delta\phi$ obtained in this manner are in satisfactory agreement with those found by the saturation current method. A. E. G.

1088. *Glow Discharge in a Transverse Magnetic Field.* **W. Groth.** (Ann. d. Physik, 78. 7. pp. 680–696, Jan., 1926.)—Strutt [Abstract 1866 (1913)] has investigated the glow discharge between coaxial cylindrical electrodes in a magnetic field parallel to the axis and found a considerable reduction of voltage thereby, *e.g.*, from 12,000 to 300 volts, the inner cylinder being the kathode. The assumption of an azimuthal bending in the magnetic field of the kathode-rays with consequent lengthening of path was supported by experiment, although Strutt was unable to observe a spiral structure. Kossel, who investigated this phenomenon later, found that for certain values of the magnetic field a regular spiral structure of the positive light could be produced, and the present investigation points to the conclusion that the discharge does not take place in separate paths, but *via* positive layers, which are so arranged that each extends in curvilinear form from anode to kathode. The experimental arrangements are very fully described with numerous diagrams and photographs. H. H. Ho.

1089. *Experimental Proof of Space Charge.* **A. Wehnelt** and **H. Bley.** (Zeits. f. Physik, 35. 5. pp. 338–345, 1926.)—The course of potential between plane, parallel electrodes, of which one is an electrically glowing electrode and therefore emits electrons, is established by the deflection of a fine beam of kathode-rays which pass through parallel to the plates. The results here obtained are of a qualitative nature, but they require theoretically the presence of a space charge for their explanation. A. E. G.

1090. *Internal Pressure, Intensity, Mercury Transfer, Cross-section and Electrical Conditions in Mercury-Vapour Lamps.* **G. S. Forbes** and **P. A. Leighton.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 53–

63, Jan., 1926.)—Internal pressure was measured in two special quartz mercury arcs developed in previous investigations. Numerous curves present the data. Pressure is a function of cross-section, voltage gradient and current only, and independent of arc length and the mode of cooling. Above 2 atmos. pressure increases about 140 mm. for unit change in voltage gradient, irrespective of other variables. In the constricted arc, 2 mm. in diameter, where the cooler absorbing vapour shell is very thin, intensity at given current strength is quite closely proportional to pressure from a few millimetres up to 5 atmos. With the addition of thermocouple inlets at the mercury surfaces and calibrated measuring tubes, mercury transfer for equal electrode temperatures was measured in the 9 mm. arc. The relations are little changed when the kathode is at least 20° to 40° hotter than the anode. Apparently zero at the lowest pressures and voltage gradients, it rises to 5 gramme-atoms per faraday from anode to kathode at 5 volts/cm. and remains nearly constant up to 25 volts/cm. Current strength is of secondary importance. These conclusions are amply demonstrated by curves. The relative importance of the electron current and the positive ion current under the various conditions studied is briefly discussed. AUTHORS.

1091. *Current and Light Emission in the Mercury Arc after cutting off the E.M.F.* **Lucy J. Hayner.** (Zeits. f. Physik, 35. 5. pp. 365–386, 1926.)—A mercury arc with incandescent kathode was intermittently excited by means of a specially constructed switch, so that after each period of the arc an auxiliary potential of any desired value (usually negative) was applied at the anode for 1/300 sec. During this time the behaviour of the currents at the electrodes was measured, or the variations in intensity of the emitted light were observed photographically. Two well-defined zones were observed. In the first, whose duration is about $2 \cdot 5 \times 10^{-4}$ sec., is found at first a strong emission of the line λ2537, gradually decreasing in intensity, while the other lines of the arc spectrum are very weak. The emission of the line λ2537 is caused by electron impacts in a slowly sinking kathode fall of potential. In the second zone, whose duration is about 2×10^{-3} sec., the other lines of the arc spectrum grow stronger and then slowly vanish. The paper concludes with a general discussion on the phenomena of the mercury arc. [See Abstract 2295 (1925).] A. W.

1092. *Positive Rays produced in Thermionic Vacuum Tubes containing Alkali-Metal Vapours.* **H. E. Ives.** (Frank. Inst., J. 201. pp. 47–69, Jan., 1926.)—The experiments here described establish the fact that it is possible to produce positive ions of the alkali metals, sodium, potassium, rubidium and cæsium by allowing the alkali-metal vapours to come into contact with a heated tungsten filament, and that the range of the filament temperatures through which this phenomenon occurs is limited. The lower limit of temperature is set by the coating of the filament with a layer of alkali metal and the upper limit, in so far as the production of positive ions *alone* is concerned, by the occurrence of the electron emission of the tungsten filament itself. It appears that at low temperatures of the alkali-metal vapour the positive carriers are aggregates of metal atoms, positively charged, while at sufficiently high temperatures the carriers are atoms of alkali metal which have been stripped of an electron. An exception, however, is presented by sodium, in which the carrier appears to consist of never fewer than two atoms. An explanation of the production of these positive carriers is offered. A. E. G.

1093. *Langevin's Theory of Ionic Mobility.* **H. R. Hassé.** (Phil. Mag. 1. pp. 139–160, Jan., 1926.)—This paper recalls attention to the theory of ionic mobility given by Langevin [Abstract 602 (1905)], and considers the applications of the theory to problems in this subject. This is the only theory of mobility which is satisfactory from a theoretical point of view, since it is based on the rigorous mathematical investigations introduced into the kinetic theory of gases by Maxwell and Boltzmann. A recalculation has been given of the numerical portion of Langevin's paper. This confirms the existence of a maximum mobility for a particular value of the distance between the centres of the ion and molecule at collision, the magnitude of the attractive forces being given. Calculations of the mobility of several gases at atmospheric pressure are made on various assumptions, more or less reasonable, as to the size and shape of the molecules and clusters involved. It is shown that the application of the theory as at present developed fails to account for some of the more fundamental experimental results, in particular for the fact that the mobility of a positive ion depends only on the nature of the gas through which it is diffusing under the influence of the external field. The paper is therefore mainly of the nature of a preliminary investigation, and further work will be necessary before the application of the theory to the calculation of mobilities and the comparison of the results with experiment can be dealt with in a satisfactory manner. A. E. G.

1094. *Mobility of Gaseous Ions in HCl gas and HCl Air Mixtures.* **L. B. Loeb.** (Nat. Acad. Sci., Proc. 12, pp. 35–41, Jan., 1926.)—In a further endeavour to answer the question as to the nature of the gaseous ion the writer undertook measurements of the mobilities of positive and negative ions in mixtures of HCl gas and air of varying composition. Practically no systematic measurements of mobilities in mixtures of varying concentrations of different gases have been made. Those of Blanc [see Abstract 508 (1909)] in mixtures of H_2, CO_2 and air, and those of Loeb and Ashley on mixtures of NH_3 and air, constitute the only ones up to the present. Certain differences between the results of Blanc on the mixtures of the less reactive gases and those of the writer and Miss Ashley on mixtures in NH_3 and air made it seem of importance to continue the investigation with other gases of dissimilar nature. The particular differences observed for NH_3 and air mixtures and their theoretical interpretation, will form the subject of another paper. The only mobility measurements made on HCl are those made by Rutherford in 1897, who found that the sum of the positive and negative mobilities in HCl was in the neighbourhood of 1·27 cm./sec. In the present mobility measurements made in pure dry HCl gas the average mobility for the positive ion at 20° C. and 760 mm. is found to be 0·65 cm./sec. per volt/cm., and 0·56 cm./sec. per volt/cm. for the negative ion. This measurement of a negative mobility, definitely less than a positive mobility, constitutes the first exception to a general rule previously assumed from observation, which indicated that the negative ion had a mobility either equal to or greater than the position ion, *but not less.* The inverse pressure law of mobilities is found to hold for both positive and negative ions down to 10·3 mm. pressure. It is concluded from this that the constant of attachment of electrons to HCl molecules to form negative ions is nearly as low as that for Cl_2 gas. Measurements of mobilities in mixtures of air and HCl show unmistakable signs of a cluster ion formation in this gas, the mobilities being lowered by marked amounts for fractions of a per cent. of HCl gas. A. E. G.

1095. *Mobility of Gas Ions in HCl Mixtures and the Nature of the Ion.* **L. B. Loeb.** (Nat. Acad. Sci., Proc. 12. pp. 42–48, Jan., 1926.)—As a result of this theoretical discussion it is stated that it would, at this juncture, be very difficult to deduce the expression for the mobility of the ions in such non-uniform mixtures of gases so that an attempt at quantitative verification would hardly be worth while. The qualitative reasoning here outlined shows that the peculiarities observed are to be expected in gaseous mixtures of widely differing dielectric constants on the writer's theory. They indicate that a definite "condensation" of molecules of higher dielectric constant about the nucleus of the ions occurs, even accompanied by a change in the concentrations of the constituents of the ion, so that it differs from the composition of the surrounding gas. That the nucleus should play such an *exceedingly* minor *rôle* in the values of the ionic mobility is very strange, for it is contrary to all mobility equations based on dynamics. A detailed discussion of this will form part of a paper on ionic mobility equations to be published shortly. A. E. G.

1096. *The Energy required to Split HCl into Atomic Ions.* **E. C. Kemble.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 1–13, Jan., 1926.)—A preliminary estimate of the potential required to split an HCl molecule into H^+ and Cl^- ions, based on the study of the infra-red absorption spectrum of HCl, was made in 1922 by the present author and gave a value of 14 volts, which was in agreement with the experimental value of Foote and Mohler. Additional measurements of the infra-red bands have been made recently and their structure reinterpreted on the basis of half quantum numbers. The present estimate is based on the fundamental hypothesis that HCl molecules can be broken up adiabatically and reversibly into H^+ and Cl^- ions without any electronic transition, and this is mathematically expressed at the outset. The paper first deals with the evaluation of energy formulæ for the various quantised states from the band spectrum data. Colby had already analysed the HCl bands, but the present author repeated the work and considered the HCl data afresh. The new values of the cofficients now obtained differ only slightly from those of Colby, but give an appreciably larger computed ionisation potential. The present analysis is based on a more general type of energy formula, wherein the coefficient of the small biquadratic term is treated as a theoretically known quantity and a small correction is applied for an apparent displacement of the lines due to the isotope effect. After full mathematical treatment the ionisation potential is given as 10·93 volts. Colby's values give 10·4 volts, whilst Born's value calculated from the grating energy of chlorine compounds and thermochemical data agrees with the value 13·7 volts obtained from the experimental ionisation potential directly observed by the electron-impact method. If Born's calculation ultimately proves correct, it is probable that the divergence (2·8 volts) of his value from the present author's will be interpreted as proof that HCl cannot be separated adiabatically into H^+ and Cl^- without an electron jump. S. G. B.

1097. *Photo-ionisation and Relative Absorption Probabilities of Cæsium Vapour.* **F. L. Mohler, P. D. Foote** and **R. L. Chenault.** (Phys. Rev. 27. pp. 37–50, Jan., 1926.)—Measurements are described of the photoelectric ionisation in gases, the method employed being that previously described by two of the authors. [See Abstract 2747 (1925).] In the case of cæsium vapour, photosensitivity curves between λ3900 and the limit show that appreciable ionisation is produced only at the wave-lengths corresponding to the principal series lines. The ionisation is due to the production of excited atoms which are ionised by atomic collision. The relative magnitude of the photo-ionisation at the different lines is in accord with the theory. A. B. W.

1098. *Faraday Cylinders in the Measurement of Electron Currents.* **E. O. Lawrence.** (Nat. Acad. Sci., Proc. 12. pp. 29–31, Jan., 1926.)—It is usually assumed that a Faraday cylinder is a complete absorber of electrons, but the reflection and secondary emission of electrons render this assumption questionable. The author describes experiments in which streams of electrons with velocities corresponding to potential drops of (*a*) 24 volts, (*b*) 100 volts, are projected into a Faraday cylinder and the current to the cylinder measured. The Faraday cylinder is constructed so that the effective length can be varied. Curves of cylinder current against retarding potential on cylinder are given for a series of effective lengths from 0·3 to 9·5 cm., the diameter of the cylinder being 2·2 cm. The results show that with the lower voltage electrons there is a regular increase in the cylinder current for a given retarding potential, with increase in cylinder length. For the higher voltage electrons the shape of the cylinder current curve is drastically modified as the effective length is changed. The author gives a qualitative explanation of the form of the curves obtained, on the basis of secondary electron emission, and concludes that Faraday cylinders of quite usual dimensions do not retain all the entering electrons, and that current retarding potential measurements generally do not indicate accurately the distribution of velocities in an electron stream. W. S. S.

1099. *Behaviour of Filter Networks with Series Condensers.* **B. Harder, H. Cohn** and **H. Warncke.** (Archiv f. Elektrot. 15. pp. 425–443, Feb. 6, 1926.)—After a short summary of fundamental formulæ for calculation and examination of filters, various special cases are considered, including (*a*) filters with different wave resistances and purely ohmic end impedances, (*b*) filters with general end impedances and consequent phase displacements, (*c*) filters applied to a very long conductor. Numerous diagrams are used to illustrate the various points discussed. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1100. *Electric Conductivity of Dielectric Compounds and of Metalloids.* **M. Rabinowitsch.** (Zeits. phys. Chem. 119. pp. 59–86, Feb., 1926.) I. General and Chloroderivatives.—The theory is discussed also with regard to Hantzsch, who ascribed dissociation to polarity in the molecule, and to Hevesy's views on the loosening of the crystal structure before fusion. The compounds examined are acetic acid, its chloroderivatives and ethylesters, as such, and dissolved in water or in absolute sulphuric acid; further, di-, tri- and tetra-chloromethane and NO_2-derivatives of methane.

The orders of the conductivities of the compounds are not the same in the two solvents. The introduction of a negative radicle into the acetic acid and into methane increases the dipole moment and the conductivity of the compound, but not of the aqueous solution. When there is no solvation of the ions by the solvent, substitution does not affect the order of the conductivities which may be reversed when there is solvation.

II. Some Hydrocarbons, Fatty Acids and Systems of Two Components of Low Conductivity.—The substances are examined, solid and liquid, as such and dissolved in ether, benzene, etc. Naphthalene and anthracene conduct better than benzene; dissolved in ether, naphthalene conducts as well as some acids. Iodine shows a small conductivity, 10^{-12}, when dissolved in carbon disulphide, and a conductivity of 10^{-7} in ether; even homœopolar compounds and elements can form ions.

III. Conductivity of the Halogens.—Since solutions of iodine in which iodine is dissolved as I_2 are conductors, and IBr dissolved in bromine is a pronounced electrolyte, the halogens must to a certain extent be capable of dissociation. The conductivity of liquid chlorine is very small, 10^{-16}. The conductivity of bromine which melts at − 7·3°, but can be undercooled to − 9°, is at 30°, 0°, − 9° (liquid), − 9° (solid), and − 18·5°, 12·63, 6·32, 5·14, 0·45, 0·08 × 10^{-10}. The conductivity of liquid iodine (melting-point 113°) rises from 3·95 to 5·35 × 10^{-5} as the temperature falls from 155° to 113°; on solidification the conductivity rises to 12·7, and then falls to 9·3 and 1·71 as the temperature is lowered to 95·4 and 25°. Iodine thus seems to possess both electrolytic and metallic conductivity. Dissociation, it is suggested, is dynamic in character; the molecules of a substance are not all alike; the moments of their dipoles can undergo continuous changes, and the observed polarisation is statistical.

H. B.

1101. *Electrical Conductivity of Single Crystals and Crystal Aggregates.* **A. Joffé** and **E. Zechnowitzer.** (Zeits. f. Physik, 35. 6. pp. 446–448, 1926.)—It is shown experimentally that the destruction of the crystal lattice of a chemically pure single crystal of sodium chloride does not involve any alteration of electrical conductivity provided no new free surfaces are produced. [See Abstract 1615 (1922).]

J. S. G. T.

1102. *Flow of Electric Current in Quartz.* **V. E. Whitman.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 31–43, Jan., 1926.)—The electrical characteristics of fused quartz and of crystalline quartz along the optic axis are investigated at 20° C. and the following points established: When a constant potential difference is maintained between two opposite sides of a specimen of either kind the current drops off rapidly. After one minute the current is less than one-tenth of its original value. The electrical resistivity of fused quartz increases as current is passed through it and reaches a value in excess of 10^{20} ohm-cm. after about twenty-four hours. The electrical resistivity of crystalline quartz along the optic axis increases as in fused quartz, but reaches a constant value of about 5 × 10^{16} ohm-cm. after about ten minutes for an impressed voltage of 360 volts. Both varieties of quartz show dielectric absorption, but the fused variety, on account of its higher resistivity, is an ideal substance in which to investigate this phenomenon. Ohm's law does not hold for crystalline quartz along the optic axis, the specific resistivity at 800 volts being only 60 % of that at

200 volts. The dielectric constant of fused quartz at 1000-cycle alternating current is 3·88 ± 0·02. The dielectric constant of crystalline quartz along the optic axis at 1000-cycle alternating current is 4·04 ± 0·04. The power factor in both varieties of quartz is less than 0·01 %.

A method is given by which a quadrant electrometer with a period of several seconds can be used to measure the current flowing in a circuit a few thousandths of a second after the circuit is closed. This method depends essentially upon precisely timing the action of two switches.

G. A. S.

1103. *Temperature-conductance Curves of Solid Salts. I. The Halides of Sodium.* **T. E. Phipps, W. D. Lansing** and **T. G. Cooke.** (Am. Chem. Soc., J. 48. pp. 112–125, Jan., 1926.)—The electrical conductance of the halides of sodium in the solid state was measured over a wide range of temperatures. The powdered salts were compressed under very high pressures into semi-transparent discs. These discs were then clamped between heavy platinum plates, which were carried on a nickel frame and heated in an electric furnace. The temperature was determined by a thermocouple placed close to the salt. In the case of sodium chloride the conductance of the disc agreed very well with that of a natural crystal. A relation between the slope of the log k, 1/T curves and the work of liberating an ion from the lattice was developed, and values for this work were calculated. It was found that the work of liberating an ion is closely related to the natural quantum of the crystal as derived from specific heat data.

F. J. B.

1104. *Contact Rectification by Metallic Germanium.* **E. Merritt.** (Nat. Acad. Sci., Proc. 11. pp. 743–748, Dec., 1925.)—Germanium contacts are found to have rectifying properties. The action is less marked with germanium than with many other materials, but the contacts are quite stable and the behaviour at different points on the surface is more uniform than in the case of most crystal rectifiers. Except in certain unusual cases the resistance of a germanium contact is less for a current flowing into the germanium from the contact point. This is also the direction of the current when an alternating e.m.f. is used—a direction opposite to that found for selenium. Different metals are substituted in the contact, and the effect of temperature variation is also considered.

G. A. S.

1105. *Photoelectric Fatigue.* **A. Predwoditelew** and **A. Witt.** (Zeits. f. Physik, 35. 10. pp. 783–791, 1926.)—It is here shown that there is a connection between photoelectric fatigue and the quantity of gas adsorbed by the photoelectric metal. From this relation it is deduced that the differential equation for adsorption in the case of zinc and antimony is of the form $dC/dt = q(C_\infty - C)^2$, where C_∞ is the adsorption capacity and q is the adsorption coefficient. The adsorption coefficients for zinc and antimony do not appear to be affected by the treatment to which the metals may have been subjected.

A. W.

1106. *Dependence of the Thermoelectric Effect from the Direction of the Field.* **G. P. Rutelli.** (Elettrotécnica, 13. pp. 6–7, Jan. 5, 1926.)—A description of experiments directed to demonstrate that the Peltier-effect varies with the orientation of the magnetic field. For this purpose a disc of bismuth, to which copper wires were soldered at the ends of a diameter, could be alternatively put in series with a battery or, with a galvanometer. The disc was situated in the field of an electromagnet, and could be rotated in it so as to vary the angle between the magnetic lines of force and the plane of the disc. The Peltier-effect on passing a current through the disc produced a difference of temperature between the two joints, which difference could be found by rapidly connecting the disc to the galvanometer. Some curves of the results obtained are given, clearly showing that the Peltier-effect is a function of angle of the field. E. B.

1107. *A New Electric Insulator.* **A. Samuel.** (Comptes Rendus, 182. pp. 206–208, Jan. 18, 1926.)—A condensation product of formic aldehyde with cresol is prepared and dehydrated. Polymerisation is arrested at the intermediary viscous stage, when the substance is still readily soluble in alcohol and acetone. It is carefully heated with S_2Cl_2, the hydrochloric acid being neutralised as it is formed. The reaction is arrested as soon as there is excess of S_2Cl_2. The final product can be purified by successive dissolution and precipitation. A white powder of density 1·18 is obtained. The author gives it the name of thiolite, which recalls its origin. It softens towards a temperature of 80° at atmospheric pressure, and fuses when strongly heated under a pressure of a few kilogrammes, then hardens and polymerises without evolution of gas. At about 150° under a heating pressure the fusion is almost instantaneously followed by complete polymerisation, rendering it possible in a very short time to prepare moulded pieces of vitreous structure. It is then very hard, and resists all solvents. It is non-fusible and non-inflammable, and does not soften under heat. It absorbs no moisture from the air, and is impervious to the action of chemical agents. The non-polymerised powder is almost at once soluble in many organic solvents. Varnishes may thus be prepared which can be rapidly evaporated and polymerised without giving off gas. They are quite neutral, very fluid even when concentrated, and have when dry a very remarkable insulating power. A copper bar covered with a film of a few thousandths of a millimetre, polymerised by heat, becomes electrified by friction and attracts light bodies like amber. A study of the chemical constitution of this product is reserved for a later occasion. E. F.

1108. *Dielectrics in Strong Fields.* **H. Schiller.** (Zeits. techn. Physik, 6. 11. pp. 588–594, 1925.)—In strong fields dielectrics become conductive. After experimental observation and considering the different possible explanations, the author concludes that immediately after the application of a high potential difference there is a steep potential fall at the electrodes, and that this steep potential fall promotes the formation of new ions and introduces conductivity. A. D.

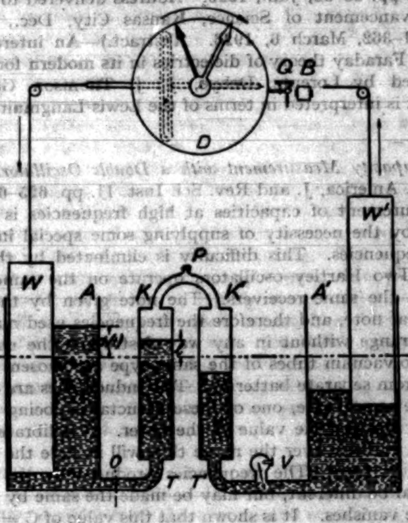
1109. *Quantum Theory of the Dielectric Constant of Gases.* **L. Pauling.** (Nat. Acad. Sci., Proc. 12. pp. 32–35, Jan., 1926.)—The author gives a modified form of the theory proposed by W. Pauli, Jr., for the dielectric constant of a gas, the molecules of which consist of diatomic dipoles. The spatial orientation of such a dipole is specified by two quantum numbers. Pauli considers integral values of these, but the author substitutes half-quantum numbers in order to make the results applicable to HCl, for which spectroscopic evidence indicates half-quantum numbers. An approximation made by Pauli is criticised, and the necessary modification in the calculations is carried out. The measurements of the dielectric constant of HCl by Zahn and a value of the moment of inertia of the molecular dipole given by Czerny are used to calculate the permanent electric moment of the molecule, μ, and its coefficient of induced polarisation, α. The former quantity is found to be $0 \cdot 3316 \times 10^{-18}$ c.g.s.u., the value given by the classical theory, using the same data, being $1 \cdot 034 \times 10^{-18}$ c.g.s.u. It is found that the experimental points lie closer to a curve of the type required by the classical theory than to any quantum theory curve. The quantum theory value of α, however, is confirmed by the refractive index of the gas for the sodium D-lines. A more extensive account of these calculations is to be presented to the "Physical Review" for publication. W. S. S.

1110. *Dielectric Constant and Molecular Structure.* **K. T. Compton.** (Science, 63. pp. 53–58, Jan., 1926. Address delivered to the Am. Assoc. for the Advancement of Science, Kansas City, Dec., 1925. Nature, 117. pp. 361–362, March 6, 1926. Abstract.)—An interesting sketch is given of the Faraday theory of dielectrics in its modern form as developed and extended by Lorentz, Debye, J. J. Thomson, Gans and Pauli. Recent work is interpreted in terms of the Lewis-Langmuir atomic models. W. S. S.

1111. *Capacity Measurement with a Double Oscillator.* **A. L. Fitch.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 625–627, Dec., 1925.) —The measurement of capacities at high frequencies is complicated in some cases by the necessity of supplying some special indicating device for these frequencies. This difficulty is eliminated by the method here described. Two Hartley oscillators operate on the same plate battery and through the same receivers. The note given by the receivers will then be a beat note, and therefore the frequencies used may be far above the audible range without in any way destroying the usefulness of the circuit. Two vacuum tubes of the same type are chosen. The filaments are lighted from separate batteries. Two inductances are chosen that are nearly of the same value, one of these inductances being variable over a range which includes the value of the other. A calibrated condenser C, continuously variable over the range that will include the capacity of the unknown X, is used. The frequencies produced by the two oscillators will in general be different, but may be made the same by varying C until the beat note vanishes. It is shown that this value of $C = X$. A. E. G.

1112. *Kathode-Ray Oscillograph.* **F. R. Terroux.** (Frank. Inst., J. 200. pp. 771–774, Dec., 1925.)—The author describes a modified kathode-ray tube of the Western Electric type, whereby the photographic speed may be sufficiently increased to obtain photographic effects for exposures of the order of 1/100 sec. One end of the tube is closed by a quartz window coated inside with phosphorescent material, the object of the quartz being to transmit the more actinic rays (ultra-violet) to a photographic film placed outside the window. A. B. W.

1113. *Hydro-oscillograph.* **V. Rojansky.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 617–623, Dec., 1925.)—This is an instrument devised to illustrate some of the fundamental relations between the variables involved in the fundamental equations pertaining to alternating electric currents. In the diagram A, K, K′ and A′ are four vertical vessels connected by the tubes T, T′ and P. W. and W′ are two heavy weights oscillating vertically in A and A′. NN′ is the level of the liquid in all four vessels with the weights W, W′ in their middle position. The pet cock P is opened while the vessels are being filled, and closed after the levels are equalised. To demonstrate the dependence of the phase of the current upon the constants of the circuit and upon the frequency of the impressed e.m.f. there is a disc D and two pointers, one recording the relative position of the levels in A and A′, and the other controlled by the flow in the tubes. In the figure W and W′ are executing sine oscillations, the position of the plungers, and therefore of the levels in A and A′ being dependent on the position of the disc D, which is rotated slowly by a motor. The projection of the black pointer (connected fast to the disc) upon the vertical through the centre of the disc represents very nearly in magnitude and sign the value of the "impressed e.m.f." at any moment. To record the phase of the "current" (*i.e.* the phase of the velocity) D is provided also with a white pointer, held to it by friction so that it only rotates with the disc if its way be unobstructed. To make the angle between the pointers equal to the phase-difference between the "impressed e.m.f." and the "current" a small vane in the chamber V oscillates according to the actual flow of the liquid, and makes and breaks an electric contact in series with an electromagnet B operating a trip Q, which has two pins projecting toward D; this occurs once each cycle, when the velocity of flow reaches zero. On making contact the upper pin moves towards the disc and remains in the way of the white pointer, while the lower pin is drawn away by the electromagnet. When contact is broken the lower pin is close to D and in the way of the white pointer. Thus the white pointer is automatically placed in respect to the black one so that the angle between



the two is equal in magnitude and sign to the angle of phase-difference between the "impressed e.m.f." and the "current." The white pointer remains in the same relative position to the black one until some of the constants or the frequency of the circuit are changed, when it is automatically shifted to a new position. T. C. H.

1114. *Use of the Diode for the Measurement of A.C. Voltages.* **J. Taylor.** (Journ. Sci. Instruments, 3. pp. 113–116, Jan., 1926.)—The paper contains a description of a method for measuring alternating-current voltages by placing a microammeter of the direct-current measuring type in series with a diode valve and high resistance. The valve is utilised to provide one-way conduction, and the indication of the microammeter is a measure of the average voltage of the alternating supply connected to the apparatus. The apparatus may be calibrated on either a.c. or d.c. There are several advantages in this method of measurement. The microammeter reading is directly proportional to the average voltage of the a.c. supply, consequently the calibration is linear and the voltmeter is equally sensitive over the whole reading range. Further, by increasing the magnitude of the resistance in series with the microammeter, the range of the apparatus may be increased to any extent. AUTHOR.

1115. *A Study of Interrupters for Induction Coils.* **R. J. Stephenson.** (Brit. J. of Radiology, 22. pp. 13–18; Disc., 19. Jan., 1926.)—Describes comparative experiments with electrolytic and mercury breaks upon oscillatory and non-oscillatory induction coils. The action of the electrolytic break is attributed to the formation of a steam layer, and it is stated that this break never actually interrupts the primary circuit, but interposes a high resistance in the continually closed primary circuit. Experiments were also carried out with alternating current and an electrolytic break, and in tuning the rate of interruption with the mercury break to the natural period of the primary circuit. B. J. L.

1116. *Use of Thermionic Voltmeter in Capacity Measurements.* **A. L. Fitch.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 71–73, Jan., 1926.)—The condenser whose capacity C is to be determined is connected in series with a non-inductive resistance R, and an alternating p.d. of frequency f is applied across the extreme terminals. The plate and filament of a thermionic tube are successively connected across R and C, and the grid potential is in each case adjusted to such a value as to cause the plate current to become zero. The author shows that if V′ is the grid potential in the first case, and V″ the grid potential in the second case, then $C = V'/(2\pi f R V'')$. A. H.

1117. *Measurements with Thermionic Valves.* **E. P. Vanoni.** (Elettrotecnica, 13. pp. 26–33, Jan. 15, 1926.)—A *résumé* of the different methods that have been suggested for utilising the properties of thermionic valves for electric measurements. E. B.

ALTERNATING CURRENTS AND MAGNETISM.

1118. *Graphical Treatment of Lines of Force.* **T. Lehmann.** (Rev. Gén. d'Él. 19. pp. 43–50, Jan. 9, and pp. 85–91, Jan. 16, 1926.)—These are continuations of the author's paper [Abstracts 125 and 2350 (1924)], expounding his graphical method of tracing the lines of magnetic force in air. In the present articles the method is extended in such a manner as to apply to lines of force in ferromagnetic media. **Errata** (*ibid.*, p. 340, Feb. 27, 1926). G. W. de T.

1119. *Magnetic Properties of Phosphores.* **E. Rupp.** (Ann. d. Physik, 78. 6. pp. 505–557, Dec., 1925.)—The magnetic behaviour of various phosphores is observed, using the method of attraction of a mass along the lines of force in a strong field. It is sought to relate, empirically, the susceptibility to other physical values characteristic of the phosphores. It was confirmed that the excited centre is more paramagnetic than the non-excited centre. In connection with the atomic magnetism of the heavy-metal constituent of the phosphore, it is found that the atomic magnetism of the diamagnetic metals Bi, Cu and Ag is a thousand times greater in subnormal phosphores than that of the metals in the crystal lattice of the pure metal. The structure of the centre of phosphorescence is discussed, and its magnetic moment is determined, the value obtained being $4 \cdot 8 \times 10^{-20}$ c.g.s. for a divalent Mn atom. [See also Abstracts 726 (1905) and 810 (1910).] G. E. A.

1120. *Magnetic Properties of the Rare Earths.* **S. Meyer.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 9–10, pp. 491–496, 1924.)—New values are given for the susceptibilities of the rare earths of atomic numbers ranging from 57 (La) to 72 (Hf). The method of measurement was one in which the specimen was suspended from one arm of an iron-free balance in a strong magnetic field. The values obtained for $k \times 10^6$ were respectively 0·01, 3·3, 5·2, 5·3, —, 0·87, 5·6, 28·2, 35, 48·8, 47·5, 38·2, 24·5, 8·8, − 0·037, − 0·023, where k is the susceptibility per gramme-atom in 1 litre. The values agree with those found by Cabrera which are expressed in Weiss magnetons. The significance of the results in determining the electronic distribution in Bohr's atomic model is pointed out. [See Abstracts 1096 (1900), 467 (1911), 1220 (1925), and 687 (1926).] G. E. A.

1121. *Magnetic Properties of the Carbonyl Radicle.* **P. Pascal.** (Comptes Rendus, 182. pp. 215–217, Jan. 18, 1926.)—Oxygen is the only substance whose magnetic properties are not recovered more or less in organic compounds. Its paramagnetism is generally replaced by a certain diamagnetism, and the contribution of the oxygen to the molecular susceptibility varies with the groups near this atom as well as with its linkage. Hitherto a value of $- 46 \times 10^7$ has been attributed to the oxygen atom, but the oxygen of the carbonyl group appears to be strangely variable. Paramagnetic in aldehydes and ketones, it appears irregularly diamagnetic in all other bodies when related to an element like oxygen or nitrogen, showing residual affinities. A detailed study of amides, urea and carbonates has shown that all observed values may be regarded as additions of three fundamental values for the Co group: (1) $- 32 \cdot 5 \times 10^{-7}$ for each NH_2 group fixed to the radicle; (2) $- 51 \times 10^{-7}$ for the first oxygen simply connected; (3) $- 36 \cdot 5 \times 10^{-7}$ for the second oxygen. Thus, again, when the nitrogen of the amino group is substituted for a negative radicle the diamagnetism arising is accentuated, but decreased by a substitution of a positive radicle. W. V. M.

1122. *On the Observed Anomaly in the Magnetism of Gases.* **A. Glaser.** (Ann. d. Physik, 78. 7. pp. 641–658, Jan., 1926.)—A continuation of previous work [Abstract 607 (1925)]. Various small improvements have been made in the apparatus as previously described, but in essentials it remains the same. An investigation of the magnetic properties of oxygen shows that in the range employed (0–15 atmos.) the susceptibility is rigorously proportional to the pressure and shows no sign of the anomaly, whereas CO and CO_2 both show curves of the type previously obtained. A table is drawn up of the moments of inertia [Θ] of the molecules of H_2, N_2, CO_1 and CO_2, for which the anomaly appears, the fields [H] in which the bend in the curve occurs and p the pressure at this sudden change. It is found that a relationship of the form $p = c' \frac{z\sqrt{H}}{\sqrt{\Theta}}$ exists, c' being a constant and z the number of electrons in the molecule. It is also shown that the susceptibility of N_2 is accurately the same as that of CO_2, a result in conformity with general considerations. The relationship between p, z, H and Θ given above may be connected with the time required for spatial quantisation. W. V. M.

1123. *Are the Magnetic Moments of Atomic Nuclei demonstrable by Means of the Deviation of a-particles?* **W. Wessel.** (Ann. d. Physik, 78. 8. pp. 757–785, Jan., 1926.)—Mathematical. The conclusion arrived at is that the magnetic moments of the nuclei are not demonstrable by α-radiation of the first order if the nuclear moments have no definite direction; in the second order their presence would be perceptible in a displacement of the deviations, as a whole, towards greater values. The amount of the change depends on the sixth power of the velocity of the α-particles and on the minus-fourth power of the nuclear charge, and is a maximum for large angles of deviation. [See also Abstract 1861 (1914).] G. E. A.

1124. *Experimental Investigations on the Magneton.* **W. Gerlach.** (Phys. Zeits. 26. pp. 816–824; Disc., 824, Dec. 16, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—A useful review of recent work on the natural unit of magnetism. Taking the hydrogen atom as the model, its electron has a moment of momentum J, and its motion gives rise to the magnetic moment $M = \frac{1}{2} \cdot \frac{e}{m} \cdot J$. The quantum theory assigns a definite value to J, from which it may be calculated that M = 5550 gauss-cms., which is the value for the Bohr magneton. The author's experiments on streams of silver atoms in a magnetic field [see Abstract 1494 (1925)] give a value for the magnetic moment of the silver atom per mol. which lies between 5400 and 5700, *i.e.* the Bohr magneton. It is very probable that the paths of the electrons arrange themselves so as to give, as far as possible, no resultant moment of momentum and no magnetic moment. This view is supported by a number of facts. Other phases discussed are the relation of atomic moment to spectrum emission and to magneto-optical phenomena. In regard to the Weiss magneton, it is pointed out that the magnetic moment of the nickel atom changes, with the proper rise of temperature, by one Bohr magneton. Weiss's views on the magneton measurements for oxygen and other substances are not accepted, and it is pointed out that, for all paramagnetic ions of the iron and platinum groups, the numbers found were 9, 14, 19, 24, 29, a sufficient proof that a larger unit than the Weiss magneton is required. The moments of the rare earths are also cited in support of the author's views that the Bohr magneton is the natural unit. G. E. A.

1125. *Magneton Numbers of Paramagnetic Elements in Complex Compounds.* **D. M. Bose.** (Zeits. f. Physik, 35. 3. pp. 219–223, 1925.)—The author has previously shown how the magneton numbers of certain ions can be calculated from the electron distributions in the various quantum levels [see Abstract 919 (1926)]. In this paper complex compounds of Cr, Fe, Co, Ni, and Cu are considered, and it is shown that the number of Bohr magnetons in the central atom is given by the difference between its effective atomic number and the atomic number of the rare gas terminating the period to which the central atom belongs (in this case krypton). When this difference is zero the compound is diamagnetic. The effective atomic number is calculated by a rule given by Sidgwick. A table is given of suggested electron distributions in the M, N and O quantum levels for the elements mentioned above, both as simple ions and as coordinating atoms in complex compounds. W. S. S.

1126. *Constant Paramagnetism in Solutions.* **Paule Collet.** (Comptes Rendus, 181. pp. 1057–1058, Dec. 21, 1925.)—Experiments on solutions of potassium bichromate give the value $63 \cdot 3 \times 10^{-6}$ for the coefficient of atomic magnetisation of chromium. The same result is found for the solid bichromate. Cobalt furnishes a second example of a solution of constant paramagnetism. [See also Abstract 2600 (1924).] G. E. A.

1127. *Paramagnetism Independent of the Temperature.* **P. Weiss.** (Comptes Rendus, 182. pp. 105–106, Jan. 11, 1926.)—The importance of the fact that there are paramagnetic substances with coefficients of magnetisation which are independent of the temperature [see preceding Abstract] is emphasised. Since the substance in question (chlorure lutéocobaltique) contains only one atom of cobalt, there is no question of compensation of elementary moments by opposite motions, and constancy of paramagnetism is therefore due to an intra-atomic action. [See also Abstract 2600 (1924).] G. E. A.

1128. *Magnetic Measurements in the Loire Basin.* **E. Tabesse.** (Comptes Rendus, 182. pp. 234–236, Jan. 18, 1926.)—A summary is given of the results obtained from observations of declination, dip and horizontal force at forty-one stations in the Loire basin. The secular variations of the elements are found by combining the present results with values previously obtained by Moureaux for a number of the stations. Local anomalies were found at Cholet, Saumur and La Châtre; at Saumur a difference of 17′ of declination was recorded between two points 150 m. apart. A. W. L.

1129. *Annual Report of Department of Terrestrial Magnetism.* **L. A. Bauer** and **J. A. Fleming.** (Carnegie Inst. of Washington, extract from Year Book No. 24. pp. 171–220, 1925.)—For previous report [see Abstract 1221 (1925)].

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1130. *Biological Action of X-radiation of Varied Wave-length.* **A. Dauvillier.** (Comptes Rendus, 181. pp. 1130–1132, Dec. 28, 1925.)—The author deals with the physical aspect of dosage in relation to the scattering effect of ionisation chamber walls, etc. Results obtained by Dognon are then criticised and corrections applied. As a result, the present author suggests that biological action is proportional to the absorbed energy and independent of wave-length. B. J. L.

1131. *The Use and Abuse of Radiator Coolidge Tubes.* **C. H. Holbeach.** (Brit. J. of Radiology, 22. pp. 20–22, Jan., 1926.)—Failure, in practice, of Radiator Coolidge Tubes is due invariably to unwarranted overloading. The author describes experiments in which tubes were deliberately overloaded to an extent resulting in the fusion of the copper anode around the tungsten target, which slipped loose from the anode. Such a result occurred only with a 500 % overload above the permissible normal operating limits. It was noticed that, at a 400 % overload, the vacuum was not destroyed by gas being evolved, as would be expected. B. J. L.

1132. *Death by Electricity—Practical Results due to Electropathological Studies.* **S. Jellinek.** (Comptes Rendus, 181. pp. 945–946, Dec. 7, 1925.)—The author has studied the physiological and pathological changes in thirty cases of electrical shock, in six of which *post-mortems* resulted. He defines the characters of electrical burns, which are different from other burns, and allows a diagnosis as to cause to be made in medico-legal cases. Such burns easily heal by aseptic necrosis without pyrexia. It is, however, impossible immediately to define the exact extent of such lesions, apparently normal tissues in the neighbourhood ultimately becoming necrotic. Similarly it is difficult to determine the extent of the resulting hæmostasis, and veins undergoing this change are cut by ligatures, resulting in delayed hæmorrhage. The prognosis both for superficial and deep injuries is, in general, good. B. J. L.

1133. *Unidirectional High-frequency Currents and their Physiological Effects.* **Cluzet** and **Chevalier.** (Comptes Rendus, 181. pp. 890–892, Nov. 30, 1925.)—Experiments have been conducted with electromedical apparatus in which the high-frequency alternating current was rectified by means of kenotrons, or by triode thermionic valves. Such rectified currents present different physiological effects from unrectified high-frequency currents. They act strongly upon striated muscle and nerve tissue. In muscle they induce a maintained, but benign, tetany. Upon nerve tissue they produce a state of formication with ultimate tetany. B. J. L.

1134. *Physiological Action of Ultra-violet Radiation transmitted by Ordinary Glass.* **J. Risler** and **F. de Courmelles.** (Comptes Rendus, 182. pp. 173–174, Jan. 11, 1926.)—The use of a 300-candle-power lamp, having an aluminium boro-silicate glass of 1 mm. thickness, and a residual atmosphere of dioxyanthracene, for spectroscopic purposes, has occasioned bilateral conjunctivitis in the case of the observer, and erythema in the case of two persons, at a distance of 2 metres. In a fourth case a worker using a lamp containing residual mercury-vapour rapidly showed erythema. When the conditions of this case were repeated experimentally with a lamp bulb of different glass, a much longer exposure produced no erythema. The authors thereby show that the transmission of ultra-violet light is selective. For radiation between $\lambda = 2960$ Å. and $\lambda = 3120$ Å. there is within this range, at $\lambda = 2960$ Å. and $\lambda = 3050$ Å. for mercury and $\lambda = 3050$ Å. for dioxyanthracene respectively, a selective increased transmission *via* this glass. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1135. *Foundations of the Static and Dynamic Displacement Theory.* **D. Reichinstein.** (Zeits. Elektrochem. 31. pp. 593–613, Nov., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—From the static displacement principle—that is, the constancy of the sum of the equilibrium concentrations—it follows that the concentration of a true solid substance in its adsorption space changes with variation in the concentration of a substance undergoing adsorption in the outer space. Such alteration of the concentration of the solid indicates that increase in the concentration of a substance adsorbed in the outer space is accompanied by diminution in the thickness of the adsorption space. This behaviour is interpreted dynamically as follows: In the diffusion of a gas or liquid into the mass of a solid—that is, in the construction of a solid solution—the coefficient of diffusion exhibits rapid diminution, so that the diffusion process is brought to a standstill long before the true equilibrium is reached; an adsorption equilibrium is thus established instead. Various applications of the principle are considered. T. H. P.

1136. *Adsorption. I. Adsorption by Coconut Charcoal from Alcohol-Benzene and Acetone-Benzene Mixtures.* **F. G. Tryhorn** and **W. F. Wyatt.** (Faraday Soc., Trans. 21. pp. 399–405, Dec., 1925.)—By evaporation of about 5 to 8 % of an alcohol-benzene or acetone-benzene mixture at 20°, and determining the change in composition by measurement of the refractive index, the partial pressures of the components of the binary mixtures may be estimated, the results thus obtained being reproducible to within about 2 %. The simultaneous adsorption of each of the two components of the binary mixture by purified coconut charcoal may be found similarly by ascertaining the increase in weight of the charcoal and the alteration in the refractive index of the residual liquid. Comparison of the results of adsorption by the charcoal from the liquid and vapour phases supports the conclusion that an adsorbed film in equilibrium with a saturated vapour must be also in equilibrium with the liquid in contact with that vapour. Alcohol is selectively adsorbed from all mixtures of alcohol and benzene. From acetone-benzene mixtures acetone is selectively adsorbed from mixtures containing up to 72 mol. per cent. of acetone in the vapour phase; for higher proportions of acetone benzene is selectively adsorbed to a slight extent. T. H. P.

1137. *The Adsorptive Equilibria of Binary Gaseous Mixtures.* **W. G. Palmer.** (Roy. Soc., Proc. 110. pp. 133–141, Jan. 1, 1926.)—Measurements are made of the voltage necessary to cohere two fine platinum or tungsten filaments when in mixtures of gases of varying partial pressures. The total pressure is found to have little or no influence on the cohering voltage. The values are compared with the known initial compositions of the films, which are assumed to contain the gases in the ratio $\sqrt{M_b}p_a/\sqrt{M_a}p_b$, where M_a and M_b are the molecular weights and p_a and p_b the partial pressures in the mixtures. The relation so found is used to determine the composition of the equilibrium film, which is given by the ratio $\sqrt{M_b}p_a s_b/\sqrt{M_a}p_b s_a$, where s_a and s_b are the rates of evaporation when the surface is covered exclusively with the one or the other gas. With carbon monoxide and oxygen an approximately constant value is, as expected from theory, obtained for the ratio s_a/s_b. With carbon monoxide and hydrogen the values for this ratio vary, and indicate the existence on the surface of three types of adsorbed units, hydrogen, carbon monoxide and a complex $CO - H_2$. With hydrochloric acid and oxygen the curves giving cohering voltage with composition are of an S-form, which is characteristic of mixtures of polar with a non-polar gas. The s_a/s_b ratio cannot be calculated in this case. Nitrogen and hydrogen mixtures are measured with tungsten filaments, and show abnormalities in that the nitrogen in the mixture does not form a complete film. Calculations of the latent heat of desorption of mixed gases from cohering voltages show that a large influence is exerted by the mode of preparing the adsorbing surface. J. N. P.

1138. *Method for Determination of the Adsorption of Ions on Colloidal Particles by Means of Donnan's Membrane Equilibrium Theory.* **H. Rinde.** (Phil. Mag. 1. pp. 32–50, Jan., 1926.)—An ion is commonly assumed to be non-dialysable only when its own dimensions are so large that it cannot pass through the pores of a semi-permeable membrane. It is possible, however, that a dialysable ion may become non-dialysable owing to its adsorption on a non-dialysable colloidal particle, and the results are given of experiments on hydrogen chloride and colloidal sulphur made in order to ascertain if such adsorption may give rise to unequal distribution of the electrolyte. The sulphur sols, prepared from concentrated sodium thiosulphate and concentrated sulphuric acid, may be obtained fairly uniform by fractional coagulation, and are stable in moderately concentrated acids. The membrane (collodion) potential has its highest value when the acidity of the colloid is small, and approaches zero when the acidity (hydrochloric) is increased. The curve for the osmotic pressure is of the same shape as the membrane potential curve, but the limiting value is not zero, but positive. It appears to be impossible to calculate either the size of the particles or the membrane equilibrium from the osmotic pressure. The quantity of adsorbed ions is fairly constant when the acidity outside of the membrane is low, and rises when the acidity increases; the dialysed sulphur sol is free from chlorine, but chlorine ions and also neutral hydrogen chloride molecules become adsorbed when the hydrochloric acid concentration rises. Bjerrum's results [Abstract 2853 (1924)] show that the amount of adsorbed kations increases with the acidity, and that q cannot be considered as a constant. Hence all the conclusions which Bjerrum bases on the assumption of the constancy of q are erroneous. Bjerrum's paper contains also a mathematical error, which is indicated. T. H. P.

1139. *Studies in Adsorption by an Optical Method, Fixation by Dispersoids of Methylene-blue within the Disperse Phase.* **A. Fodor** and **R. Riwlin.** (Chem. Soc., J. pp. 102–112, Jan., 1926.)—The adsorption of methylene-blue by colloidal solutions is determined by measuring the absorption curves, for different wave-lengths, of the dye in varying concentrations before and after the addition of the colloid. With albumin, casein, gelatin, saponin and aluminium hydroxide sols the form of the curve is unaffected, indicating that no adsorption occurs; with kaolin a selective light absorption results together with an upward displacement of the curve, indicating mechanical adsorption (lyosorption), and with sodium-silicate solutions and silica sol the position of the minimum of the curve is markedly displaced and the form of the curve is changed, indicating chemical combination between the adsorbent and the dye (chemosorption). The addition neither of acid nor alkali causes at first any considerable alteration in the position of the minimum of the curve, but after standing the presence of alkali leads to an appreciable displacement. J. N. P.

1140. *Adsorption of Ions on a Mercury Surface.* **W. A. Patrick** and **P. W. Bachman.** (J. Phys. Chem. 30. pp. 134–136, Jan., 1926.)—Mercury was forced by slight pressure through chamois skin directly into a column of dilute aqueous mercurous sulphate or acetate solution contained in a tube about 4 ft. high and 1 in. wide. The small drops of mercury, after falling through the solution, were collected at the bottom of the tube, which was arranged so that the mercury drained off automatically. During this process the mercurous ions are adsorbed on the surface of the drops of mercury to an appreciably greater extent than the sulphate or acetate ions. T. H. P.

1141. *Influence of the Adsorption of Neutral Molecules by an Electric Field.* **A. Frumkin.** (Zeits. f. Physik, 35. 10. pp. 792–802, 1926.)—A quantitative theory of the influence of the adsorption of neutral molecules by the electric field at the surface is developed, and is applied to furnish an interpretation of the significance of the characteristic electro-capillarity curves observed in presence of capillary-active organic substances. T. H. P.

1142. *Some Phenomena of Capillary Chemistry.* **R. Dubrisay.** (Comptes Rendus, 181. pp. 1142–1143, Dec. 28, 1925.)—A solution in benzene of a fatty acid was allowed to drip from a burette with the tip immersed in water or a weak alkali. The drops are smaller at higher temperatures for 1 % solutions of palmitic, stearic and oleic acids in benzene, when dripping into pure water, but are larger when dripping into N/400 or N/1000 NaOH, *i.e.* the surface-tension of the acid solution decreases with rising temperature, but an opposite effect is produced in presence of alkalis. This is in accord with the hypothesis that the activity of an acid is greater as its salt is less soluble in water. T. M. L.

1143. *Nature of the Interfacial Layer between an Aqueous and a Non-aqueous Phase.* **F. L. Usher.** (Faraday Soc., Trans. 21. pp. 406–424, Dec., 1925.)—Determinations of the number of ions which attach themselves to the spherical particles of a uniform stable suspension of gamboge during the process of neutralising their electric charge give results indicating that the majority of the neutralising (flocculating) ions are employed in displacing ions originally attached to the particles, but not contributing to their effective charge. The total charge on the flocculating ions is therefore greatly in excess of the effective charge considered responsible for the stability and electrokinetic behaviour of the particles. Dilution of suspensions results in increase of the number of ions attached by each particle in the course of flocculation, the net charge on the particles thus increasing with their mean distance apart. Parallel determinations of the flocculating powers of different electrolytes and of their effect in reducing the concentration of the ions stabilising a suspension show that, among ions of the same valency, the flocculating power is determined by the solubility product of the compound formed from the flocculating and stabilising ions. A theory involving the slight dissociation of a layer of surface molecules is considered preferable to other current theories in accounting for the results of experiments on mobility taken in conjunction with those on flocculation and for the effect on dilution in increasing the stability of aqueous suspensions. T. H. P.

1144. *Structure of Gelatin Gels.* **E. O. Kraemer.** (J. Phys. Chem. 29. pp. 1523–1527, Dec., 1925.)—On the supposition that a gelatin gel consists of threads or short chains of sol units or "molecules" loosely knit together in three dimensions, the average value of the interval between two threads may be shown to be $19\sqrt{\frac{1}{c}}$ times the thickness of the threads, where c is the percentage concentration of the gel. Thus, in a 0·5 % gel, which exhibits a bulk elasticity, the average interval will be twenty-seven times the thickness—that is, about 100 millimicrons. As aggregation of the units to thicker threads could result only in increase in the spaces, the structure of gelatin gels must be considerably looser and less homogeneous than a true solution. When particles of mercury about 200 to 250 millimicrons in radius are mixed with gelatin solutions of 0·5 % or greater concentration before gelation, Brownian movement of the mercury particles in the gel is prevented, but begins to appear on gentle heating. In weaker gels measurable Brownian motion persists. This technique is not able to detect the heterogeneïties of such gels, but lends no support to the view that the structure is of molecular magnitude. T. H. P.

1145. *Stability of Solutions of Carbon Dioxide.* **A. Kling** and **A. Lassieur.** (Comptes Rendus, 182. pp. 130–131, Jan. 11, 1926.)—When a solution of carefully purified carbon dioxide in water prepared by distillation in platinum apparatus, and quite free from ammonia, is kept in a platinum flask plugged with cotton-wool, it gradually loses its carbon dioxide; at the same time the pH of the solution assumes the value about 5·8, at which it remains [see Abstract 884 (1926)]. The same result is obtained if the solution is placed under a bell-jar in presence of an alkali hydroxide, provided that the latter is free from ammonia. Evidently ordinary water retains carbon dioxide in solution owing to the presence in the water of small proportions of either ammonia or a fixed base. T. H. P.

1146. *Solubility of Hydrogen in Tin and Aluminium at High Temperatures.* **L. L. Bircumshaw.** (Phil. Mag. 1. pp. 510–522, Feb., 1926.)—Owing to the long time necessary for the attainment of equilibrium, it appears to be practically impossible to saturate a metal with a gas by keeping the unstirred metal at constant temperature in contact with the gas. Results are given which refute the statement of Sievert's that hydrogen is insoluble in tin and aluminium [Abstract 800 (1911)]. At 800° 1 kg. of tin dissolves 4·19 c.c. of hydrogen measured at normal temperature and pressure. Evidence is obtained of pronounced solubility of hydrogen in aluminium just above the melting-point of the metal. The rate at which hydrogen dissolves in tin is determined by the rate at which the gas diffuses through the bulk of the metal. The complete removal of the dissolved gas from a metal by heating in a vacuum is a prolonged operation, apparently owing to the relatively high surface-tension of the medium in which the gas-bubbles are formed. T. H. P.

1147. *The Theory of Molecular Weight Determinations in Mixed Solvents.* **C. Wagner.** (Zeits. phys. Chem. 119. pp. 53–58, Feb., 1926.) —The Duhem relation $\Sigma i(N_i \,.\, dp_i/p_i)_{T.P.} = 0$, where N_i is the number of molecules of the i components in the mixture and p_i their partial pressures, is extended to correlate solubilities in ternary systems with partial pressures and boiling-points. In cases where the partial pressure of a component p_3 is proportional to the concentration—*i.e.* where the solute has the same molecular size in the vapour form as in solution $p_3 = \chi c$, where χ is the proportionality factor and is inversely proportional to the solubility. The following expressions are derived to represent the influence of a third component on the partial pressures p_1 and p_2 of the two constituents of the solvent $p_1 = p_{10}\ e^{-c[1-(1-x)ln\chi/x]}$ and $p_2 = p_{20}\,e^{-c[1+x ln\chi/x]}$, where p_{10} and p_{20} are the partial pressures over the mixed solvent when free from the third component, $x = N_1/N_1 + N_2$, and $c = N_3/N_1 + N_2$. The elevation of boiling-point is given by the expression :—

$$\Delta T = c \,.\, \frac{1 + (x - \nu) ln\chi/x}{\nu \,.\, \lambda_1/RT^2 + (1 - \nu)\lambda_2/RT^2}\ \nu = p_1/p_1 + p_2$$

and denotes the molecular fraction of the first component in the vapour phase. The elevation of boiling-point of a mixed solvent is thus determined, not only by the molecular concentration, but by the factor $(x - \nu) ln\chi/x$. This factor becomes zero if the composition of liquid and vapour phase are identical $(x - \nu = 0)$, or if the solubility of the third component is independent of the composition of the solvent $(ln\chi/dx = 0)$, in which case the relative concentration of the two solvent components in the vapour phase is not affected by the presence of the third component. Modified formulæ are developed for the case where the partial pressure of the third component is not directly proportional to the concentration, but where $p_3 = \chi c^q$, where q represents the ratio of the molecular dimensions in the vapour and solution respectively. [See Abstract 561 (1926).] J. N. P.

1148. *Separation of Crystalloids from one another by Dialysis.* **L. Kahlenberg.** (Phil. Mag. 1. pp. 385–394, Feb., 1926.)—Not only is it possible to separate different crystalloids from one another by dialysis, but, if the proper septum and the proper solvent are used, colloids will pass through the membrane and crystalloids remain behind. By means of a vulcanised rubber membrane of the rubber-dam material used by dentists, and with pyridine as solvent, sulphur may be separated from sugar, naphthalene from sugar, sulphur from silver nitrate, naphthalene from silver nitrate, camphor from sugar, camphor from silver nitrate, sulphur from lithium chloride, and naphthalene from lithium chloride. The pyridine solution contained 1·5 % of each of the two substances, and the first-named of each pair passed through the membrane. For aqueous solutions use may be made of copper ferrocyanide membranes precipitated in thin parchment paper of good quality, but better results are obtainable with membranes of lanoline supported in either fine China silk, or parchment paper, or collodion. The lanoline membranes in particular exhibit pronounced selective osmotic properties, which are due to the presence in the lanoline of a high proportion of cholesterol. Similar properties are shown by the analogous ingredient of plant oils (phytosterol), and it is probable that the selective osmotic properties of living cells are dependent on delicate films of these sterols. T. H. P.

1149. *Determination of Some Physical Properties of Steel.* **J. H. Andrew, M. S. Fisher** and **J. M. Robertson.** (Roy. Soc., Proc. 110. pp. 391–422, Feb. 1, 1926.)—Contains the results of an investigation of the constitution of steel by the application of new experimental methods, including the determination of electrode potential, electrical resistance, and change of resistance during tempering. It is considered that in all steels, annealed or quenched, the values of electrode potential obtained are those of alpha iron, modified by the presence of varying amounts of carbon, nickel and chromium in solution. The curves for quenched steels show that the electrode potential decreases as the carbon-content increases, which means that the iron is rendered less active by dissolved carbon. The electrode potential curve obtained after tempering at 680° indicates that carbon dissolves in alpha iron below Ac_1. From the tempering-resistance curves taken by the continuous measurement of the resistance it is evident that, as martensite tempers much more rapidly than austenite, martensite can never accumulate during tempering. The intermittent method of investigation would lead to the opposite conclusion. The determination of the electrode potential of steels tempered at different temperatures shows that the state attained at the conclusion of tempering at any temperature below 650° is different from the annealed state. At each temperature the steel attains a definite condition, retaining a certain amount of carbon in solution in the ferrite. Pearlite, sorbite and troostite do not differ in state of division only, but in the amount of carbon in solution in the ferrite, to which may be attributed the remarkable differences in their properties. C. O. B.

1150. *Restraint of Exaggerated Grain Growth in Critically Strained Metal.* **G. L. Kelley** and **J. Winlock.** (Frank. Inst., J. 201. pp. 71–77, Jan., 1926.)—Exaggerated grain growth in critically strained metals may often be prevented by a preliminary heating for a more or less prolonged period of time at temperatures below which the exaggerated grain growth is liable to occur, as shown by experiments with low carbon steel. With aluminium, however, this preliminary heating does not prevent the exaggerated grain growth, but raises the temperature at which this growth occurs. Owing to the variety and complexity of the factors affecting this phenomenon, such as variations in grain size, existence of grain fragments, nature and extent of deformation and strain in the metal, strain gradients, etc., it is very difficult to obtain conclusive results. B. W. C.

1151. *Phosphor-Bronze. Thermal Investigation of the System. Copper-Phosphorus-Tin.* **L. C. Glaser** and **H. J. Seemann.** (Zeits. techn. Physik, 7. 1. pp. 42–46, 1926.)—The ternary system, copper-phosphorus-tin, in the technically important region—*viz.* up to 25 % tin and 8 % phosphorus—was investigated. Cooling curves were determined for various copper, phosphorus-tin mixtures. It was found that a ternary eutectic, consisting of copper 80·7 %, phosphorus 4·5 %, tin 14·8 %, exists, and has a melting-point of 628° C. The limits of the mixed crystal formation, the exact position of which was doubtful owing to the well-known liquation of the copper-tin alloys, was determined by the aid of X-ray and electrical conductivity measurements. F. J. B.

1152. *Distillation of Mercury.* **Stammreich.** (Phys. Zeits. 26. pp. 843–844; Disc., 845–847, Dec. 16, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Discussion as to why the distillate from gold amalgam contains gold. Various hypotheses suggested and discussed. A. D.

1153. *Inflammability of Fire-damp Mixtures.* **M. J. Burgess** and **R. V. Wheeler.** (Safety in Mines Research Board, Paper 15. Colliery Guardian, 131. pp. 81–82, Jan. 8, 1926.)—Recent results are given of experimental determinations of the limiting compositions of mixtures of fire-damp and air that are capable of causing explosion under the varying conditions of coal-mining. It was found that the widest range of percentage of methane was where the flame is propagated vertically upwards. In this case the lower limit is least where the mixture is free to expand, and the upper limit is greatest where the mixture is totally enclosed. The variation due to ordinary changes of temperature are negligible. The significant values of the limits are given in the following table :—

	Percentage of Methane.	
	Lower Limit.	Upper Limit.
Upward propagation of flame—		
Enclosed	5·40	14·80
Free	5·25	14·00
Horizontal propagation of flame—		
Either enclosed or free	5·40	14·30
Downward propagation of flame	6·00	13·40

A mixture of fire-damp and air containing about 5 % of methane can propagate flame (*a*) under certain limiting conditions of turbulence mixture, or (*b*) when the mixture is travelling as a slow current. S. R. R.

1154. *Photochemical Oxidation of Leuco-bases.* **B. H. Carroll.** (J. Phys. Chem. 30. pp. 130–133, Jan., 1926.)—Experiments made with various members of the malachite green series show that the photochemical oxidation of leuco-bases offers little hope of utility as a photographic process, but that it may be followed quantitatively by optical methods of analysis, and is well adapted to the study of photochemical catalysis. T. H. P.

1155. *Formation of Ozone from Air at Increased Pressure.* **H. v. Wartenberg** and **M. Treppenhauer.** (Zeits. Elektrochem. 31. pp. 633–636, Dec., 1925.)—The results are given of experiments on the action of the silent discharge on dry air at various pressures up to 5 atmos. in glass and in aluminium tubes. The consumption of energy was measured by the three-ammeter method, a capacity being inserted in parallel with the ammeter to cut out the high-frequency currents which the ozone tube itself superposes on the alternating current employed; the calorimetric method was used to control the energy used. Owing to the rapid increase in the electric resistance of the gas with increase in the pressure, the discharge is concentrated on a smaller space. If this is taken into account, the yield of ozone from any tube (grammes per hour) increases slightly to a flat maximum as the pressure is increased to 2 atmos., and afterwards falls. The current diminishes more rapidly than the reaction space as the pressure rises. The energy consumption at first decreases, owing to the restriction of the reaction space, then rises somewhat, and decreases again and more rapidly at the higher pressures. The energy efficiency, and also the yield in grammes of ozone per volt-ampere-hour, at first increases, and then diminishes with increasing rapidity. From the technical standpoint, the slightly improved results obtained by slight increase in the pressure are more than counterbalanced by the necessity of using stronger tubes and of keeping the apparatus gas-tight. Should ozonised air at high pressures become necessary, it would be more advantageous to ozonise the air and then compress it with a turbo-compressor working without lubricant. **Errata** (*ibid.*, 32. p. 218, April, 1926). T. H. P.

1156. *Formation of Ozone with High-frequency Alternating Currents.* **H. v. Wartenberg** and **M. Treppenhauer.** (Zeits. Elektrochem. 31. pp. 636–641, Dec., 1925.)—With increase of the frequency, up to 300,000 periods, the formation of ozone does not appear to be influenced. The zero yield with very high velocity of flow of the oxygen amounts, as with lower frequencies, to about 200 grammes per kw.-hr. On the other hand, for very low velocities of flow, the limiting concentration influenced by de-ozonisation diminishes rapidly with increasing frequency, and at 300,000 periods is only just above 1 gramme per cubic metre. No experimental data are available to show if this is a result of the frequency or if it depends mainly on thermal de-ozonisation. Similar relations seem to hold in the formation of ammonia. T. H. P.

1157. *Reactions of Light-excited Bromine.* **J. Eggert.** (Phys. Zeits. 26. pp. 865–868, Dec. 23, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Illumination of ethyl maleate or its carbon tetrachloride solution in presence of bromine results in conversion of the ester into the stereoisomeric fumarate, the reaction being exothermic and the action of the bromine that of a sensitiser [see Abstract 1310 (1924)]. This reaction is accompanied by the exothermic transformation of the ethyl maleate to ethyl dibromosuccinate. The absorption of a single quantum $h\nu(\lambda = 436\ \mu\mu)$ by a 0·1 N solution of bromine in ethyl maleate causes stereoisomerisation of 295 molecules and addition of 8 molecules of bromine. These figures are not altered by variation of the intensity of the illumination in the proportion 1 : 10, or by 70-fold dilution of the ester with carbon tetrachloride. The two quantum equivalents vary to somewhat different extents with the temperature, and, whilst that for the stereoisomerisation (ϕ) is apparently independent of the concentration of the bromine, that for the addition of bromine (α) varies directly with such concentration. Further, the value of ϕ depends on the proportion of maleic to fumaric ester, whereas α is independent of this proportion. Both vary with the wave-length of the active radiation, the values for $\lambda = 436\ \mu\mu$ being about double those for $\lambda = 546\ \mu\mu$. A theory of the mechanism of the reaction is advanced in explanation of the above phenomena. T. H. P.

1158. *The Action of Radon on Mixtures containing Ammonia and an Oxide of Carbon.* **K. C. Bailey.** (Roy. Dublin Soc., Proc. 18. pp. 165–168, Jan., 1926.)—Two alternative chemical reactions are possible when ammonia and carbon-monoxide gases react, resulting in primary products of hydrocyanic acid and cyanic acids respectively. The course of these reactions were determined in the presence of radon, with the result that cyanic acid is shown to be the only product. Similar experiments were carried out with carbon dioxide and ammonia, producing cyanate. An observation of Cameron and Ramsay that carbon is deposited when radon acts upon carbon monoxide or dioxide is not confirmed. B. J. L.

1159. *The Antagonistic Action of Ions in the Neutralisation of Sols.* **H. B. Weiser.** (J. Phys. Chem. 30. pp. 20–33, Jan., 1926.)—An investigation is made of the antagonistic action between the oppositely charged ions of a precipitating electrolyte through the fact that the greater the adsorption of the stabilising ion the greater must be the adsorption of the precipitating ion to effect neutralisation. Measurements are made of the precipitation values of mixtures of electrolytes with arsenious sulphide sols. In some cases the degree of adsorption is measured by analysis of the supernatant solution. The electrolytes investigated are barium chloride in presence of different alkali chlorides, barium ferrocyanide with alkali ferrocyanides, and ferrocyanides in presence of potassium chloride. It is found that the precipitation values for sols of mixtures of two electrolytes may be additive or greater or less than the additive values. The determining factors are: (1) The effect of each precipitating ion on the adsorption of the other; (2) the stabilising action of ions having the same charge as the sol; and (3) the relatively greater adsorbability of ions at lower concentrations. The antagonistic action between precipitating ions of the same charge is important in raising the critical concentrations above the additive values only in case the ions show a marked difference in adsorbability. J. N. P.

1160. *Calculation of Velocity Constants.* **G. Schmid.** (Zeits. phys. Chem. 119. pp. 8–18, Jan., 1926.)—For the calculation of the velocity constant of a reaction of the *n*th order, it is shown that the following method entails less labour than the ordinary method, and yields results equal in accuracy to those arrived at by the method of least squares. An even number of measurements of the concentration of the reacting substance are made. The logarithms or the $-\frac{1}{c^{n}-1}$ powers of the first half of these concentrations are added, and from this sum is subtracted that of the logarithms or $-\frac{1}{c^{n}-1}$ powers of the second half. This remainder is divided by the difference between the sum of the second half and that of the first half of the times; the quotient represents the velocity constant [see Moesveld, Abstract 1258 (1923)]. T. H. P.

1161. *Photosensitisation by Optically Excited Mercury Atoms: the Hydrogen-Oxygen Reaction.* **A. L. Marshall.** (J. Phys. Chem. 30. pp. 34–46, Jan., 1926.)—A central quartz vessel containing a mercury arc is surrounded successively by a cooling cylinder, a cylinder to which chlorine and bromine can be admitted to act as a light filter, and a reaction vessel containing purified hydrogen and oxygen and mercury-vapour. All the radiation that is absorbable by mercury-vapour can thus be employed. The chlorine-bromine light filter absorbs all the radiation in the range 2900–5000 Å.U., so that, apart from the yellow and green lines, the only light of any intensity reaching the vessel is 2536 Å.U., which is the wave-length employed. Experiments are carried out in the temperature range 25°–70° C. In cases where an excess of hydrogen is present the pressure-time curves show an initial break at a point corresponding to saturation with water-vapour, and the curve is then linear until the reaction is complete, the rate being thus independent of the total pressure. When oxygen is present in excess the rate of combination decreases rapidly as the reaction proceeds. The temperature coefficients are very involved, and appear to be affected firstly by the increased vapour-pressure of the mercury at the higher temperatures giving an increased light absorption, and secondly by an increased yield per quantum absorbed. The rates of reaction measured are in close accordance with the kinetic equation $d[H_2O]/dt = K_1[H_2]/[H_2] + [O_2]$, which supports the view that hydrogen atoms are formed by collisions between molecular hydrogen and excited mercury molecules, while the energy absorbed by the oxygen is degraded as heat. The probability of this collision determines the rate of the reaction, and is proportional to the above expression. It is considered that a chain reaction is involved, and several possible mechanisms are proposed which involve the formation of HO_2, HO and H_2O_2. J. N. P.

1162. *Studies in Catalytic Combustion. II. Union of Carbon Monoxide and Oxygen in Contact with Nickel and Copper and their Oxides.* **W. A. Bone** and **G. W. Andrew.** (Roy. Soc., Proc. 110. pp. 16–34, Jan. 1, 1926.)—Experiments on the lines of those already described [Abstract 640 (1926)], but with nickel gauze in place of gold, show that the formation of a reactive Ni-CO, or possibly O-Ni-CO complex in the surface layer, is, or in definable circumstances may become, a prime factor in the catalytic combustion, which may be visualised as involving interactions either in a CO-Ni-O system, or between a nickel carbonyl complex, and adsorbed or atomised oxygen. In a freshly reduced condition copper is a more active catalyst than nickel, but after treatment with carbon monoxide at a relatively low temperature it becomes covered with a film of a fairly stable Cu-CO complex, and becomes highly unreactive. Experiments have been made also with copper and nickel oxides, and the results support the supposition that the real catalytic combination of carbon-monoxide and oxygen over the surfaces of copper and nickel and their oxides is a process different from and independent of either the oxidation of a "carbonyl" film formed primarily, or the reduction of a metallic oxide, although, under certain conditions, one or the other of these processes may occur simultaneously. Certainly with copper, and probably with nickel, the catalytic combination involves only the "occlusion" of the respective gases. T. H. P.

1163. *Pressures developed on Explosion of Gaseous Mixtures at High Densities.* **W. T. David.** (Phil. Mag. 1. pp. 334–337, Feb., 1926.)—Commenting on a paper by Bone, Newitt and Townend [see Abstract 2403 (1925)], the author expresses the opinion that the explanation advanced of the increase with increasing initial pressure of the ratio of maximum pressure to initial pressure during the explosion of inflammable gaseous mixtures contained in closed vessels to be insufficient to account for the whole of the observed increase. A number of other contributory causes are enumerated, the most important of these being (1) more complete combustion in the denser mixtures at the moment of maximum pressure;

(2) a decrease in the specific heat of the gaseous products of combustion at the higher temperatures developed as the density of the gaseous mixtures increases. Experimental evidence is adduced to support the latter suggestion. A. B. C. L.

1164. *Standard Electrical Cells.* **Marion Eppley.** (Frank. Inst., J. 201. pp. 17–46, Jan., 1926.)—The various types of standard cells proposed are compared, and the Weston cell is selected as being generally most satisfactory. A detailed account is given of the making up of this cell, including the preparation of the materials used. The effects on the e.m.f. and its temperature-coefficient of varying the concentration of the solutions and the amalgam and of adding a third metal to the amalgam are discussed, as also the desirability of having the electrolyte acid rather than neutral. G. A. S.

1165. *Temperature Coefficients of Reference Electrodes.* **L. J. Bircher and G. D. Howell.** (Am. Chem. Soc., J. 48. pp. 34–40, Jan., 1926.)—Application of the method used by Fales and Mudge to determine the temperature coefficient of the saturated calomel electrode [Abstract 964 (1921)] to various reference electrodes shows that all of these become more electronegative as the temperature rises. The experiments on sulphuric acid-hydrogen electrodes and those of Fales and Mudge on the 0·1 M hydrochloric acid-hydrogen electrode do not support the assumption made in the development of the temperature coefficient of the 0·1 N calomel electrode, namely that the e.m.f. of the cell H_2, HCl (0·1 M) :: H^+(M), H_2 is proportional to the absolute temperature. The fact that sulphuric acid-hydrogen electrodes become more electronegative as the temperature rises indicates that the activity of the hydrogen ion increases with the temperature so rapidly that any increase in potential indicated by an increased value of T in the equation $E = (RT/nF) \log_e (a_{H^+}/a = 1)$ is counterbalanced. T. H. P.

1166. ***The Application of the Quinhydrone Electrode to the Measurement of pH Values in Solutions containing Copper Ions and other Divalent Ions.*** **J. B. O'Sullivan.** (Faraday Soc., Trans. 21. pp. 319–324; Disc., 325, Dec., 1925.)—In applying a quinhydrone electrode in conjunction with a hydrogen electrode to potential measurements with an electrolyte of N/200 sulphuric acid solution in presence of various sulphates, it is found that fairly constant and reproducible values are obtained except with cadmium sulphate, which gives a gradual increase from a variable initial value. This anomalous behaviour is attributed to poisoning of the hydrogen electrode by cadmium or some impurity present in the salt. A quinhydrone electrode in conjunction with a calomel electrode gives a constant potential with acidified copper sulphate, but with neutral copper sulphate a drift of potential occurs which is attributed to gradual coagulation of the colloidal particles of cupric hydroxide produced by hydrolysis, whereby absorbed acid is set free. It is shown that, unlike the hydrogen electrode, the quinhydrone electrode can be employed with salts electropositive to hydrogen, but is limited in its applicability by its reducing power. Thus it cannot be employed even in moderately acid solutions of the salts of mercury, silver, or gold, which have normal electrode potentials of more than 0·7 volt. J. N. P.

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1167. *The Measurement of Indicator Ranges in an Acetone-Water Mixture.* **F. M. Gray and G. M. Westrip.** (Faraday Soc., Trans. 21. pp. 326–336; Disc., 337, Dec., 1925.)—Determinations of the pK_a values of a number of weak acids in an acetone-water solvent containing 10 vols. of water in 100 vols. of acetone-water mixture are made by measuring with the quinhydrone electrode the pH values of the acids in presence of an equivalent concentration of their sodium salts. With these data the concentrations of acids and salts required to give further buffer solutions having other pH values are calculated and checked by measurement with the electrode. By employing phthalic, acetic, glycollic, monochloracetic and hydrochloric acids in presence of their alkali salts a continuous scale is thus developed, having pH values ranging from 2·5 to 12·5. Measurements are made of the pH ranges of a large number of carefully purified indicators in the specified solvent by means of these standard solutions. Tables are given of the pH ranges and colour changes of the indicators in this solvent, together with the corresponding values in water and the concentrations most suitable for their use. A number of measurements are made both by indicators and the electrode in the ranges where two buffer mixtures overlap. Except with brom-cresol purple the pH differences shown by the two buffer scales agree to within 0·1 pH with those given by the electrode. [See Abstract 2628 (1924).] J. N. P.

1168. *Activity Coefficient of Hydrochloric Acid in Concentrated Solutions of Strong Electrolytes.* **H. S. Harned.** (Am. Chem. Soc., J. 48. pp. 326–342, Feb., 1926.)—Revising his previous work, the author makes measurements of the e.m.f. of cells of the type $H_2|HCl_{(m_1)}, MCl_{(m_2)}|HgCl|Hg$, where M is an alkali metal (Li, Na, K) and m_1 and m_2 indicate the concentrations of acid and salt in mols. per 1000 gr. of water. The log of the activity coefficient of the acid varies linearly with the acid concentration at constant total molality up to 3 M total concentration. Within the concentration range 0·01 to 0·1 M fifteen series of results agreed with Hückel's approximate calculations [Abstract 1267 (1925)], like those of Scatchard [Abstract 2638 (1925)]. The constants calculated for the individual electrolytes after Debye and Hückel from the mixture data were observed to agree with other determinations. It is concluded that this agreement would also hold for the chlorides of barium, strontium, calcium. The theory of Debye and Hückel would, however, appear not to be directly applicable to the alkali hydroxides without the addition of a further factor; in solutions of lithium chloride and hydrochloric acid above 4 M the dielectric constant would otherwise assume a negative value. It was found that the hydrogen electrode should be freshly coated for every determination. H. B.

1169. *The Hydration of Strong Electrolytes, the Viscosity of their Aqueous Solutions, and the Dilution Law.* **J. N. Sugden.** (Chem. Soc., J. pp. 174–196, Jan., 1926.)—The hydration of sucrose and some strong electrolytes is determined from the distribution of acetic acid between their aqueous solutions and amyl alcohol. Over a concentration range from N to N/10 the hydration is independent of the dilution, and is an additive property of anion and kation respectively, with either a positive or negative value. A modified hydration theory is suggested, according to which only kations are hydrated, whilst anions depolymerise the solvent molecules displacing the reaction $(H_2O)_3 \rightleftarrows 3H_2O$ towards the right. The first process tends to decrease and the second to increase the activity of the water. Hydration is therefore a composite effect, the salts having negative hydration numbers being those in which the influence of the anion predominates. Solutions of such salts have abnormally high vapour-pressures. The hydration theory is correlated with viscosity in that in the Arrhenius formula $\log \eta/\eta_0 = \theta c$ the constant θ is expressed in terms of the apparent molecular hydration H and a more general constant K or $\theta = K(H - H_0)$, where H_0 represents the apparent hydration of a salt in the hypothetical case where the positive value of the kation counterbalances the depolymerising value of the anion, and is thus without effect on the viscosity of the solvent. A hydration correction is applied to calculations of the "degree of dissociation" of strong electrolytes from freezing-point measurements, and evidence is adduced in favour of a cube-root dilution law $(1 - \alpha) = K\sqrt[3]{n}$. The law is found to be closely followed by many salts. J. N. P.

1170. *The Electrode Position of Zinc from Sulphate Solutions.* **A. L. Marshall.** (Faraday Soc., Trans. 21. pp. 297–314; Disc., 315–318, Dec., 1925.)—The author stated that a convenient copper coulometer had been developed for measuring currents up to 15 amps., and that measurements had been made of the effects of varying temperature current density, and varying concentration of zinc and acid, on the efficiency of zinc deposition. It had been found that with pure solutions the efficiency always increased with rising temperature; more rapidly the lower the zinc and the higher the acid content of the solution. A study had been made of the effects of temperature and concentration changes on the single potential of the zinc electrode with varying current densities. An explanation had been given of these variations, and also of the increase in efficiency of zinc deposition with rising temperature, based on chemical polarisation. The effect of varying temperature and concentration of zinc and acid on the power consumption of the zinc cell had been investigated. Curves were given to show the effects of the presence of small quantities of copper, iron, manganese and antimony salts in the electrolyte on the efficiency and nature of the zinc deposit. *Discussion.*—**F. G. Donnan**, the president of the society, stated that the principal object of the work was to ascertain the effect of temperature on the kathodic efficiency in the electrolysis of zinc in sulphate solutions, which were frequently highly acid. Many of the results had thus a bearing on the interesting process patented by Pring and Tainton. The author of the paper had had previous experience of electrolytic zinc extraction on a large scale, and his results, both as regards pure solutions and those containing other metals, were very interesting in showing how the efficiency-temperature curves were affected by impurities as well as by current density. **J. N. Pring** showed deposits of zinc $\frac{1}{16}$ in. in thickness, obtained by the process of Tainton and Pring, with a current density of 100 amps. per sq. ft. and a current efficiency of 89 %, representing a consumption of 1·65 kw.-hr. per lb. of zinc. **S. Field, H. Borns, W. E. Harris** and **R. Mond** also joined in the discussion. J. B. C. K.